# CONTROL DEVICE FOR FUEL CELL SYSTEM

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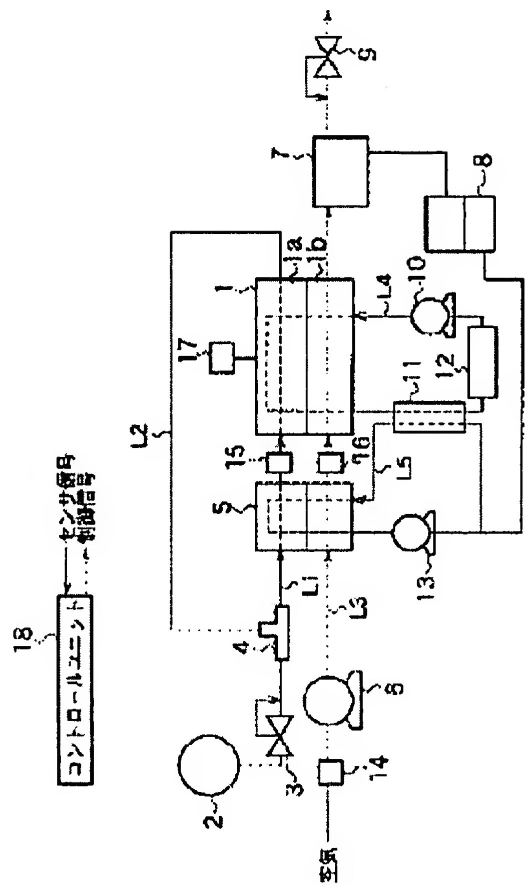
Abstract of **JP2002280029**

PROBLEM TO BE SOLVED: To excellently keep a wetting state of an electrolyte membrane to optimize the power generation capacity of a fuel cell, to reduce the consumption amount of pure water for wetting, and to prevent water plugging. SOLUTION: A fuel cell system is equipped with a fuel cell stack 1 constituted by interposing the electrolyte membrane between an air electrode 1b and a hydrogen electrode 1a; a hydrogen gas passage L1 for supplying air and hydrogen gas to the fuel cell stack 1; and a humidifier 5 for humidifying air and hydrogen gas to be supplied to the fuel cell stack 1 through the hydrogen gas supply passage L1, and the fuel cell system is controlled with a control unit 18. The control unit 18 is equipped with a power generating state detection means for detecting a power generating state of the fuel cell stack 1; and a humidification control means for controlling a gas humidifying means so as to control a dew point of at least one of oxidizing agent gas and fuel gas supplied to the fuel cell with the gas supply means, according to a power generating state detected with the power generating state detection means.



JAPANESE [JP,2002-280029,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS

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## CLAIMS

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[Claim(s)]
[Claim 1] While being constituted by an oxidizer pole and the fuel electrode on both sides of an electrolyte membrane and supplying oxidant gas to the above-mentioned oxidizer pole side The fuel cell which fuel gas is supplied to the above-mentioned fuel electrode side, and is generated, and a gas supply means to supply oxidant gas and fuel gas to the above-mentioned fuel cell, In the control unit of the fuel cell system which controls the fuel cell system equipped with a gas humidification means to humidify the oxidant gas and fuel gas which are supplied to the above-mentioned fuel cell by the above-mentioned gas supply means The generation-of-electrical-energy condition detected with a generation-of-electrical-energy condition detection means to detect the generation-of-electrical-energy condition of the above-mentioned fuel cell, and the above-mentioned generation-of-electrical-energy condition detection means is embraced. The control unit of the fuel cell system characterized by having the oxidant gas supplied to the above-mentioned fuel cell by the above-mentioned gas supply means, and the humidification control means which controls the above-mentioned gas humidification means to control one [ at least ] dew-point of fuel gas.
[Claim 2] The above-mentioned humidification control means is the control unit of the fuel cell system according to claim 1 characterized by controlling the above-mentioned gas humidification means to make the dew-point of oxidant gas and/or fuel gas higher than the time of the predetermined load of the above 1st when the generation-of-electrical-energy condition detected by the above-mentioned generation-of-electrical-energy condition detection means is in a heavy load condition higher than the 1st predetermined load.
[Claim 3] When the generation-of-electrical-energy condition detected by the above-mentioned generation-of-electrical-energy condition detection means is in a low loading condition lower than the 2nd predetermined load set as the value lower than the predetermined load of the above 1st, the above-mentioned humidification control means While controlling the above-mentioned gas supply means to make higher than the time of the predetermined load of the above 2nd the ratio of the oxidant gas supplied to the generation-of-electrical-energy condition of the above-mentioned fuel cell, and/or fuel gas The control unit of the fuel cell system according to claim 1 characterized by controlling the above-mentioned gas humidification means to make the dew-point of oxidant gas and/or

fuel gas higher than the time of the predetermined load of the above 2nd.
[Claim 4] It is the control unit of the fuel cell system of the publication [ be / they / any of claims 1-3 ] which carries out [ a humidification medium flowing into the humidification medium passage which has semipermeable membrane, the above-mentioned gas humidification means being equipped with the humidifier style which oxidant gas and fuel gas, and a humidification medium contact through the above-mentioned semipermeable membrane, and humidifies oxidant gas and fuel gas, and the above-mentioned humidification control means controlling the flow rate of the cooling medium which supplies to the above-mentioned humidification medium passage, and controlling the dew-point of the above-mentioned oxidant gas and/or fuel gas, and ] as the description.
[Claim 5] The oxidant gas feeder current way which supplies oxidant gas to the above-mentioned fuel cell from the above-mentioned gas supply means, And/or, the detour passage which is established in the fuel gas feeder current way which supplies fuel gas to the above-mentioned fuel cell from the above-mentioned gas supply means, bypasses the above-mentioned gas humidification means and supplies oxidant gas and/or fuel gas to the above-mentioned fuel cell, A flow control means to adjust the quantity of gas flow which passes through the above-mentioned detour passage, So that the rate of the quantity of gas flow which passes the above-mentioned gas humidification means, and the quantity of gas flow which passes through the above-mentioned detour passage may be adjusted and the dew-point of the above-mentioned oxidant gas and/or fuel gas may be controlled The control unit of a fuel cell system given in any of claims 1-4 characterized by having further the flow rate control means which controls a flow control means they are.
[Claim 6] While being constituted by an oxidizer pole and the fuel electrode on both sides of an electrolyte membrane and supplying oxidant gas to the above-mentioned oxidizer pole side The fuel cell which fuel gas is supplied to the above-mentioned fuel electrode side, and is generated, and a gas supply means to supply oxidant gas and fuel gas to the above-mentioned fuel cell, In the control unit of the fuel cell system which controls the fuel cell system equipped with a gas humidification means to humidify the oxidant gas and fuel gas which are supplied to the above-mentioned fuel cell by the above-mentioned gas supply means The temperature of the above-mentioned fuel cell detected with a temperature detection means to detect the temperature of the above-mentioned fuel cell, and the above-mentioned temperature detection means is embraced. The control unit of the fuel cell system characterized by having the oxidant gas supplied to the above-mentioned fuel cell by the above-mentioned gas supply means, and the dew-point control means which controls the above-mentioned gas humidification means to control one [ at least ] dew-point of fuel gas.
[Claim 7] The above-mentioned dew-point control means is the control unit of the fuel cell system according to claim 6 characterized by making low the dew-point of the above-mentioned oxidant gas and/or fuel gas, so that the temperature of the above-mentioned fuel cell detected with the above-mentioned temperature detection means is low.
[Claim 8] The above-mentioned dew-point control means is the control unit of the

fuel cell system according to claim 6 characterized by controlling the above-mentioned gas humidification means to make the dew-point of oxidant gas higher than the dew-point of fuel gas when the temperature of the fuel cell detected with the above-mentioned temperature detection means is higher than predetermined temperature.
[Claim 9] The above-mentioned dew-point control means is the control unit of the fuel cell system according to claim 6 characterized by controlling the above-mentioned gas humidification means to make the dew-point of oxidant gas lower than the dew-point of fuel gas when the temperature of the fuel cell detected with the above-mentioned temperature detection means is lower than predetermined temperature.
[Claim 10] It is the control unit of the fuel cell system of the publication [ be / they / any of claims 6-9 ] which carries out [ a humidification medium flowing into the humidification medium passage which has semipermeable membrane, the above-mentioned gas humidification means being equipped with the humidifier style which oxidant gas and fuel gas, and a humidification medium contact through the above-mentioned semipermeable membrane, and humidifies oxidant gas and fuel gas, and the above-mentioned humidification control means controlling the flow rate of the cooling medium which supplies to the above-mentioned humidification medium passage, and controlling the dew-point of the above-mentioned oxidant gas and/or fuel gas, and ] as the description.
[Claim 11] The oxidant gas feeder current way which supplies oxidant gas to the above-mentioned fuel cell from the above-mentioned gas supply means, And/or, the detour passage which is established in the fuel gas feeder current way which supplies fuel gas to the above-mentioned fuel cell from the above-mentioned gas supply means, bypasses the above-mentioned gas humidification means and supplies oxidant gas and/or fuel gas to the above-mentioned fuel cell, A flow control means to adjust the quantity of gas flow which passes through the above-mentioned detour passage, So that the rate of the quantity of gas flow which passes the above-mentioned gas humidification means, and the quantity of gas flow which passes through the above-mentioned detour passage may be adjusted and the dew-point of the above-mentioned oxidant gas and/or fuel gas may be controlled The control unit of a fuel cell system given in any of claims 6-10 characterized by having further the flow rate control means which controls a flow control means they are.

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## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is used as driving sources, such as an automobile, and relates to the control unit of the fuel cell system which faces driving a fuel cell in detail about the control unit of the fuel cell system which drives the fuel cell which generates electricity by supplying air as hydrogen gas and oxidant gas as fuel gas, and controls the dew-point of air and/or hydrogen gas.

[0002]
[Description of the Prior Art] As a conventional fuel cell system, what used the so-called fuel cell stack is known as a source of a generation of electrical energy. It comes to carry out two or more laminatings of the fuel cell structure which the fuel cell stack consisted of on both sides of the solid-state polyelectrolyte film with the oxidizer pole and the fuel electrode through a separator. As a fuel cell system using such a fuel cell stack, what is indicated, for example by JP,10-255828,A is known.
[0003] By the fuel cell system currently indicated by this JP,10-255828,A, the polymer electrolyte fuel cell which operates at low temperature comparatively is explained by by supplying hydrogen as air and a fuel as an oxidizer. Moreover, in this conventional fuel cell system, it made it face that a fuel cell generated electricity, and since it was necessary to maintain in the condition of fully carrying out humidity of the solid-state polyelectrolyte film, actuation which humidifies the air and hydrogen which are supplied to a fuel cell using pure water was carried out.

[0004]
[Problem(s) to be Solved by the Invention] However, in said conventional fuel cell system, it faces carrying out humidity of the solid-state polyelectrolyte film, and if there are too few amounts of humidification to the oxidant gas and/or fuel gas (it is only hereafter called the "distributed gas".) which are supplied to a fuel cell, an electrolyte membrane will dry, and the problem that sufficient generated output cannot be obtained occurs.
[0005] On the other hand, in the conventional fuel cell system, when there are too many amounts of humidification to distributed gas, the consumption of the pure water used as an object for humidification may increase, or the amount of water of

condensation in a fuel cell may increase. The water remaining in which the water of condensation becomes is hard to be discharged from the inside of a fuel cell when it comes to such a condition, and a lot of water piles up occurs, sufficient generated output may be unable to be obtained and the problem which promotes degradation of the component part of a fuel cell further occurs.

[0006] Then, this invention is proposed in view of the problem mentioned above, and it offers control of the pure-water consumption for humidification, and the control unit of the fuel cell system which can prevent water remaining while it maintains the damp or wet condition of an electrolyte membrane good and optimizes the generation-of-electrical-energy capacity of a fuel cell.

[0007]

[Means for Solving the Problem] In order to solve an above-mentioned technical problem, in invention concerning claim 1 While being constituted by an oxidizer pole and the fuel electrode on both sides of an electrolyte membrane and supplying oxidant gas to the above-mentioned oxidizer pole side The fuel cell which fuel gas is supplied to the above-mentioned fuel electrode side, and is generated, and a gas supply means to supply oxidant gas and fuel gas to the above-mentioned fuel cell, In the control unit of the fuel cell system which controls the fuel cell system equipped with a gas humidification means to humidify the oxidant gas and fuel gas which are supplied to the above-mentioned fuel cell by the above-mentioned gas supply means The generation-of-electrical-energy condition detected with a generation-of-electrical-energy condition detection means to detect the generation-of-electrical-energy condition of the above-mentioned fuel cell, and the above-mentioned generation-of-electrical-energy condition detection means is embraced. It has the oxidant gas supplied to the above-mentioned fuel cell by the above-mentioned gas supply means, and the humidification control means which controls the above-mentioned gas humidification means to control one [ at least ] dew-point of fuel gas.

[0008] It is the control unit of a fuel cell system according to claim 1, and the above-mentioned humidification control means controls the above-mentioned gas humidification means by invention concerning claim 2 to make the dew-point of oxidant gas and/or fuel gas higher than the time of the predetermined load of the above 1st, when the generation-of-electrical-energy condition detected by the above-mentioned generation-of-electrical-energy condition detection means is in a heavy load condition higher than the 1st predetermined load.

[0009] In invention concerning claim 3, it is the control unit of a fuel cell system according to claim 1. The above-mentioned humidification control means When the generation-of-electrical-energy condition detected by the above-mentioned generation-of-electrical-energy condition detection means is in a low loading condition lower than the 2nd predetermined load set as the value lower than the predetermined load of the above 1st While controlling the above-mentioned gas supply means to make higher than the time of a predetermined load the ratio of the oxidant gas supplied to the generation-of-electrical-energy condition of the above-mentioned fuel cell, and/or fuel gas, the above-mentioned gas humidification means is controlled to make the dew-point of oxidant gas and/or fuel gas higher than the time of the predetermined load of the above 2nd.

[0010] It is the control unit of a fuel cell system given in any of claims 1-3 they are, and it has the humidifier style which a humidification medium flows into the humidification medium passage which has semipermeable membrane, and oxidant gas and fuel gas, and a humidification medium contact through the above-mentioned semipermeable membrane, and humidifies oxidant gas and fuel gas, and the above-mentioned humidification control means controls the flow rate of the cooling medium which supplies to the above-mentioned humidification medium passage, and controls the dew-point of the above-mentioned oxidant gas and/or fuel gas by invention concerning claim 4.
[0011] In invention concerning claim 5, it is the control unit of a fuel cell system given in any of claims 1-4 they are. The oxidant gas feeder current way which supplies oxidant gas to the above-mentioned fuel cell from the above-mentioned gas supply means, And/or, the detour passage which is established in the fuel gas feeder current way which supplies fuel gas to the above-mentioned fuel cell from the above-mentioned gas supply means, bypasses the above-mentioned gas humidification means and supplies oxidant gas and/or fuel gas to the above-mentioned fuel cell, A flow control means to adjust the quantity of gas flow which passes through the above-mentioned detour passage, It has further the flow rate control means which controls a flow control means to adjust the rate of the quantity of gas flow which passes the above-mentioned gas humidification means, and the quantity of gas flow which passes through the above-mentioned detour passage, and to control the dew-point of the above-mentioned oxidant gas and/or fuel gas.
[0012] In order to solve an above-mentioned technical problem, in invention concerning claim 6 While being constituted by an oxidizer pole and the fuel electrode on both sides of an electrolyte membrane and supplying oxidant gas to the above-mentioned oxidizer pole side The fuel cell which fuel gas is supplied to the above-mentioned fuel electrode side, and is generated, and a gas supply means to supply oxidant gas and fuel gas to the above-mentioned fuel cell, In the control unit of the fuel cell system which controls the fuel cell system equipped with a gas humidification means to humidify the oxidant gas and fuel gas which are supplied to the above-mentioned fuel cell by the above-mentioned gas supply means The temperature of the above-mentioned fuel cell detected with a temperature detection means to detect the temperature of the above-mentioned fuel cell, and the above-mentioned temperature detection means is embraced. It has the oxidant gas supplied to the above-mentioned fuel cell by the above-mentioned gas supply means, and the dew-point control means which controls the above-mentioned gas humidification means to control one [ at least ] dew-point of fuel gas.
[0013] In invention concerning claim 7, it is the control unit of a fuel cell system according to claim 6, and the above-mentioned dew-point control means makes low the dew-point of the above-mentioned oxidant gas and/or fuel gas, so that the temperature of the above-mentioned fuel cell detected with the above-mentioned temperature detection means is low.
[0014] It is the control unit of a fuel cell system according to claim 6, and the above-mentioned dew-point control means controls the above-mentioned gas humidification means by invention concerning claim 8 to make the dew-point of

oxidant gas higher than the dew-point of fuel gas, when the temperature of the fuel cell detected with the above-mentioned temperature detection means is higher than predetermined temperature.
[0015] It is the control unit of a fuel cell system according to claim 6, and the above-mentioned dew-point control means controls the above-mentioned gas humidification means by invention concerning claim 9 to make the dew-point of oxidant gas lower than the dew-point of fuel gas, when the temperature of the fuel cell detected with the above-mentioned temperature detection means is lower than predetermined temperature.
[0016] In invention concerning claim 10, it is the control unit of a fuel cell system given in any of claims 6-9 they are. The above-mentioned gas humidification means It has the humidifier style which a humidification medium flows into the humidification medium passage which has semipermeable membrane, and oxidant gas and fuel gas, and a humidification medium are contacted through the above-mentioned semipermeable membrane, and humidifies oxidant gas and fuel gas. The above-mentioned humidification control means controls the flow rate of the cooling medium supplied to the above-mentioned humidification medium passage, and controls the dew-point of the above-mentioned oxidant gas and/or fuel gas.
[0017] In invention concerning claim 11, it is the control unit of a fuel cell system given in any of claims 6-10 they are. The oxidant gas feeder current way which supplies oxidant gas to the above-mentioned fuel cell from the above-mentioned gas supply means, And/or, the detour passage which is established in the fuel gas feeder current way which supplies fuel gas to the above-mentioned fuel cell from the above-mentioned gas supply means, bypasses the above-mentioned gas humidification means and supplies oxidant gas and/or fuel gas to the above-mentioned fuel cell, A flow control means to adjust the quantity of gas flow which passes through the above-mentioned detour passage, It has further the flow rate control means which controls a flow control means to adjust the rate of the quantity of gas flow which passes the above-mentioned gas humidification means, and the quantity of gas flow which passes through the above-mentioned detour passage, and to control the dew-point of the above-mentioned oxidant gas and/or fuel gas.
[0018]
[Effect of the Invention] Since a gas humidification means is controlled to control one [ at least ] dew-point of the oxidant gas supplied to a fuel cell, and fuel gas according to invention concerning claim 1, while being able to control at the optimal dew-point, being able to supply oxidant gas or fuel gas to a fuel cell, maintaining the damp or wet condition of an electrolyte membrane good and optimizing the generation-of-electrical-energy capacity of a fuel cell, control of the pure-water consumption for humidification and prevention of water remaining can be carried out. That is, irrespective of the operational status of a fuel cell, by maintaining the damp or wet condition of an electrolyte membrane good, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled, the generation-of-electrical-energy capacity of a fuel cell can be optimized, and, according to invention concerning claim 1, control of the pure-water consumption for humidification can be further realized in the time

of a heavy load condition and a low loading condition as compared with the case where it considers as the same dew-point.
[0019] Since according to invention concerning claim 2 the dew-point of oxidant gas and/or fuel gas is made higher than the time of the 1st predetermined load when it is in a heavy load condition higher than the 1st predetermined load, desiccation of the electrolyte membrane which is easy to generate in the heavy load condition of a fuel cell can be prevented.
[0020] When a generation-of-electrical-energy condition is in a low loading condition lower than the 2nd predetermined load set as the value lower than the predetermined load of the above 1st according to invention concerning claim 3 While making higher than the time of the predetermined load of the above 2nd the ratio of the oxidant gas supplied to the generation-of-electrical-energy condition of a fuel cell, and/or fuel gas Since the dew-point of oxidant gas and/or fuel gas is made higher than the time of a predetermined load While enlarging the rate of flow in oxidant gas and/or the fuel cell of fuel gas and being able to control water remaining Desiccation of the electrolyte membrane by having enlarged the rate of flow of oxidant gas and/or fuel gas can be prevented, and desiccation prevention and water remaining prevention of an electrolyte membrane can more certainly be reconciled as compared with invention concerning claim 1 and claim 2.
[0021] Since according to invention concerning claim 4 the flow rate of the cooling medium supplied to humidification medium passage is controlled and the dew-point of oxidant gas and/or fuel gas is controlled, while being able to control at the optimal dew-point, being able to supply oxidant gas or fuel gas to a fuel cell, maintaining the damp or wet condition of an electrolyte membrane good and optimizing the generation-of-electrical-energy capacity of a fuel cell, it is realizable to prevent control of the pure-water consumption for humidification and water remaining.
[0022] Since according to invention concerning claim 5 the rate of the quantity of gas flow which passes a gas humidification means, and the quantity of gas flow which passes through detour passage is adjusted and the dew-point of oxidant gas and/or fuel gas is controlled, a dew-point is controllable independently by oxidant gas and fuel gas by having detour passage. Therefore, according to invention concerning this claim 5, as compared with invention concerning claim 1 - claim 3, further, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled, and the generation-of-electrical-energy capacity of a fuel cell can be optimized. Furthermore, according to invention concerning this claim 5, control of the pure-water consumption for humidification is realizable.
[0023] Since one [ at least ] dew-point of the oxidant gas supplied to a fuel cell by the gas supply means and fuel gas is controlled according to the temperature of a fuel cell according to invention concerning claim 6, while being able to control at the optimal dew-point, being able to supply oxidant gas or fuel gas to a fuel cell, maintaining the damp or wet condition of an electrolyte membrane good and optimizing the generation-of-electrical-energy capacity of a fuel cell, control of the pure-water consumption for humidification and water remaining can be prevented. That is, irrespective of the operational status of a fuel cell, by

maintaining the damp or wet condition of an electrolyte membrane good, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled, the generation-of-electrical-energy capacity of a fuel cell can be optimized, and, according to invention concerning claim 6, control of the pure-water consumption for humidification can be further realized in the time of a heavy load condition and a low loading condition as compared with the case where it considers as the same dew-point.
[0024] Since according to invention concerning claim 7 the dew-point of oxidant gas and/or fuel gas is made low and there is so little change of the maximum vapor tension to change of a dew-point that the temperature of a fuel cell is low when the temperature of a fuel cell is low, the rate of a moisture content to the amount of fuel gas and the amount of oxidant gas in the fuel electrode and oxidizer pole of a fuel cell increases, and it can respond to more moisture condensing.
[0025] According to invention concerning claim 8, since the dew-point of oxidant gas is made higher than the dew-point of fuel gas when the temperature of a fuel cell is higher than predetermined temperature, the desiccation prevention of an electrolyte membrane and the generating prevention of water remaining in an oxidizer pole are realizable.
[0026] According to invention concerning claim 9, since the dew-point of oxidant gas is made lower than the dew-point of fuel gas when the temperature of a fuel cell is lower than predetermined temperature, the water remaining generating prevention in an oxidizer pole is realizable.
[0027] Since according to invention concerning claim 10 the flow rate of the cooling medium supplied to humidification medium passage is controlled and the dew-point of oxidant gas and/or fuel gas is controlled, while being able to control at the optimal dew-point, being able to supply oxidant gas or fuel gas to a fuel cell, maintaining the damp or wet condition of an electrolyte membrane good and optimizing the generation-of-electrical-energy capacity of a fuel cell, it is realizable to prevent control of the pure-water consumption for humidification and water remaining.
[0028] Since according to invention concerning claim 11 the rate of the quantity of gas flow which passes a gas humidification means, and the quantity of gas flow which passes through detour passage is adjusted and the dew-point of oxidant gas and/or fuel gas is controlled, a dew-point is controllable independently by oxidant gas and fuel gas by having detour passage. Therefore, according to invention concerning this claim 5, as compared with invention concerning claim 1 - claim 3, further, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled, and the generation-of-electrical-energy capacity of a fuel cell can be optimized. Furthermore, according to invention concerning this claim 5, control of the pure-water consumption for humidification is realizable.
[0029]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing.
[0030] This invention is applied to the fuel cell system constituted as shown in drawing 1 .

[0031] The [fuel cell structure of a system] This fuel cell system is equipped with the fuel cell stack 1 which hydrogen content gas and fuel gas are supplied, and is generated. This fuel cell stack 1 consists of two or more fuel cell structures which ****(ed) with the separator the fuel cell structure which opposite-**(ed) the fuel electrode (hydrogen pole 1a) and the oxidizer pole (air pole 1b) for example, on both sides of the solid-state polyelectrolyte film. This fuel cell stack 1 generates electricity by hydrogen gas being supplied to the hydrogen pole 1a side as fuel gas, for example, is used as driving sources, such as an automobile, while air is supplied to the air pole 1b side as oxidant gas.
[0032] A fuel cell system is equipped with the hydrogen gas supply passage L1 which supplies it to the fuel cell stack 1 through an ejector pump 4 and a humidifier 5 after regulating the pressure of the hydrogen gas stored in the hydrogen tank 2 with the hydrogen pressure regulating valve 3.
[0033] The hydrogen pressure regulating valve 3 is carrying out a switching action according to the control signal from a control unit 18, and adjusts the pressure of the hydrogen gas within a fuel cell system. The humidifier 5 has the composition of passing pure water, in the semipermeable membrane fabricated for example, in the shape of a pipe, is contacting the air from the hydrogen gas and the compressor 6 from an ejector pump 4 to semipermeable membrane, and has composition which carries out humidification of the hydrogen gas and air through semipermeable membrane.
[0034] Moreover, this fuel cell system is equipped with the hydrogen gas circulating flow way L2 which supplies the exhaust gas used as the hydrogen gas from the hydrogen pole 1a side, and the mixed gas of a steam to an ejector pump 4, and supplies it to the fuel cell stack 1 through a humidifier 5 again.
[0035] Furthermore, this fuel cell system is equipped with the air supply passage L3 which supplies the air from the outside to the fuel cell stack 1 through a compressor 6 and a humidifier 5. A compressor 6 supplies the air of the flow rate which followed the control signal from the control unit 18 to the fuel cell stack 1 through the air supply passage L3.
[0036] In this fuel cell system, including a steam and liquid hydrogen, it is separated into a part for liquid hydrogen, and a steam by the water separator 7, and a part for liquid hydrogen is stored in a demineralised water tank 8, and the exhaust gas by the side of air pole 1b from the fuel cell stack 1 is constituted so that a steam may be discharged outside through the air pressure regulating valve 9. The air pressure regulating valve 9 adjusts the pressure of the air within a fuel cell system by carrying out a switching action according to the control signal from a control unit 18.
[0037] Furthermore, this fuel cell system is further equipped with the pure-water circulating flow way L5 which circulates the cooling water circulating flow way L4 which circulates cooling water in the fuel cell stack 1, and the pure water for humidifying the hydrogen gas and fuel gas which are supplied at the fuel cell stack 1 again. The intermediate heat exchanger 11 which carries out heat exchange between cooling water and pure water is arranged in this cooling water circulating flow way L4 and the pure-water circulating flow way L5.
[0038] The cooling water pump 10, the heat exchanger 11, and the radiator 12 are

arranged in this cooling water circulating flow way L4. Cooling water is made to flow in the fuel cell stack 1, it cools with a radiator 12 and a cooling water pump 10 is made to circulate through the cooling water which was made to carry out heat exchange between the pure water of the pure-water circulating flow way L5 by intermediate heat exchanger 11, and became high temperature by generation of heat of the fuel cell stack 1 about the cooling water from the fuel cell stack 1 by driving a cooling water pump 10 in this fuel cell system. Thereby, a fuel cell system maintains the fuel cell stack 1 to predetermined temperature with cooling water.
[0039] The pure water pump 13 for humidification which leads the pure water accumulated in the demineralised water tank 8 to a humidifier 5, and intermediate heat exchanger 11 are arranged in the pure-water circulating flow way L5. In this fuel cell system, by driving the pure water pump 13 for humidification, the pure water accumulated in the demineralised water tank 8 is supplied to intermediate heat exchanger 11, carry out heat exchange of the pure water between cooling water, it is made to heat, and a humidifier 5 is supplied. Thereby, within a humidifier 5, pure water is supplied, for example in a pipe-like semi-transparent membrane, and when hydrogen gas and air pass to a semi-transparent membrane, it humidifies to hydrogen gas and air.
[0040] Furthermore, it has the air flow rate sensor 14 which is prepared in the preceding paragraph of a compressor 6 and detects the flow rate of air in a fuel cell system, the hydrogen pressure force sensor 15 which detects the pressure of the hydrogen gas supplied to the fuel cell stack 1, the air-pressure sensor 16 which detects the pressure of the air supplied to the fuel cell stack 1, and the condition sensor 17 which is connected with the fuel cell stack 1 and detects the generation-of-electrical-energy condition or the temperature of the fuel cell stack 1. Each sensors 14-17 supply the sensor signal detected and acquired to a control unit 18.
[0041] A control unit 18 outputs the control signal which controls each part of a fuel cell system based on the sensor signal from each sensors 14-17. A control unit 18 carries out dew-point control processing which controls the dew-point of the hydrogen gas supplied to the fuel cell stack 1, and/or air according to the condition of the fuel cell stack 1.
[0042] The 1st dew-point control processing by the control unit 18 - the 4th dew-point control processing are explained as actuation of an above-mentioned fuel cell system below [actuation of a fuel cell system].
[0043] In the 1st dew-point control processing of "the 1st dew-point control processing", a control unit 18 makes high the dew-point of hydrogen gas and/or air, when the ejection current (load) from the fuel cell stack 1 is large. At this time, a control unit 18 recognizes the generation-of-electrical-energy condition of the fuel cell stack 1, i.e., the load of the fuel cell stack 1, based on a sensor signal from the condition sensor 17, as it makes a dew-point high according to the magnitude of a load, it makes [ many ] the amount of drives of the pure water pump 13 for humidification, and it carries out control which supplies many pure-water flow rates to a humidifier 5.
[0044] Here, in hydrogen pole 1a of the fuel cell stack 1, hydrogen is consumed by the reaction (H2 ->2H++2e-), and water is generated by the reaction of the oxygen

contained in air in air pole 1b, and the hydrogen (2H+) from hydrogen pole 1a (1/2O2+2H++2e-->H2O). Especially if the dew-point of air and hydrogen gas is too low, the polyelectrolyte film will dry in near a gas inlet, and it will become decline in generating efficiency, and promotion of degradation of an electrolyte membrane. On the contrary, if the dew-point of air and hydrogen gas is too high, in order that a lot of liquid hydrogen may condense in the fuel cell stack 1, it becomes easy to generate water remaining. On the other hand, in a control unit 18, the above-mentioned 1st dew-point control processing is carried out.
[0045] Moreover, on the property of the fuel cell stack 1, the temperature gradient of the circulating water temperature in the outflow of cooling water of the fuel cell stack 1 and the circulating water temperature in the inflow of cooling water of the fuel cell stack 1 becomes large, so that the ejection current from the fuel cell stack 1 is large, since the ejection current from the fuel cell stack 1 is large, namely, the calorific value of the fuel cell stack 1 becomes large so that it is a heavy load as shown in drawing 3 . For this reason, the mean temperature of the fuel cell stack 1 becomes high, so that the ejection current from the fuel cell stack 1 is large.
[0046] Furthermore, maximum vapor tension increases the fuel cell stack 1 rapidly, so that the dew-point of hydrogen gas and/or air becomes high, as shown in drawing 4 .
[0047] From drawing 3 and drawing 4 , it is shown that the saturated water vapor pressure within the fuel cell stack 1 increases, and it is hard to condense a part for liquid hydrogen, so that the fuel cell stack 1 is in a heavy load condition. Therefore, in order to prevent desiccation of the polyelectrolyte film, a control unit 18 controls highly the dew-point of the air in the outlet of a humidifier 5, and/or hydrogen gas with reference to a table as shown in drawing 5 , when the fuel cell stack 1 is in a heavy load condition. The table shown in drawing 5 shows relation with the dew-point of the hydrogen gas supplied to the fuel cell stack 1, and/or air from the pure-water flow rate passed in a humidifier 5, and a humidifier 5, and the amount control of drives of the pure water pump 13 for humidification based on the dew-point required of the fuel cell stack 1 by the control unit 18 is carried out.

[0048] It is made lower [ if control made into the dew-point as a heavy load condition when a control unit 18 is the same when the fuel cell stack 1 is in a low loading condition is carried out, will not generate desiccation of the polyelectrolyte film, but ] than the dew-point at the time of a heavy load condition, since the condensation rate for liquid hydrogen increases and it becomes easy to generate water remaining here.
[0049] According to the fuel cell system equipped with the control unit 18 which carries out this 1st dew-point control processing, the amount of drives of the pure water pump 13 for humidification is enlarged, desiccation of an electrolyte membrane is prevented so that the dew-point of hydrogen gas and/or air may be made high in a heavy load condition, the amount of drives of the pure water pump 13 for humidification is made small, and generating of water remaining is prevented so that it may be made lower than the dew-point at the time of a heavy load condition in a low loading condition.

[0050] Therefore, irrespective of the operational status of the fuel cell stack 1, by maintaining the damp or wet condition of an electrolyte membrane good, the generating efficiency fall by desiccation of the polyelectrolyte film or water remaining can be controlled, and, according to this fuel cell system, the generation-of-electrical-energy capacity of a fuel cell can be optimized. Furthermore, according to this fuel cell system, as compared with the case where it considers as the amount of drives of the same pure water pump 13 for humidification, control of the pure-water consumption for humidification is realizable in the time of a heavy load condition and a low loading condition.
[0051] In addition, the field between the 1st above-mentioned predetermined load and the 2nd predetermined load means an inside load field among the operating range of a fuel cell.
[0052] In the 2nd dew-point control processing of "the 2nd dew-point control processing", control corresponding to being easy to generate according to the rate of flow of distributed gas being slow, namely, being easy to generate water remaining in a low loading condition with little gas supply volume to the fuel cell stack 1 is carried out.
[0053] In the 2nd dew-point control processing, a control unit 18 controls the hydrogen pressure regulating valve 3 and/or a compressor 6 rather than outside in a low loading condition in the low loading condition of the fuel cell stack 1 to make a SUTOIKI ratio (SR) high. Here, a SUTOIKI ratio is a ratio of the amount of distributed gas to the amount of reactant gas within the fuel cell stack 1, and it is controlled by the normal state by the bigger value than "1."
[0054] Moreover, in this 2nd dew-point control processing, a control unit 18 carries out control which makes high the dew-point at the time of a low loading condition as shown in drawing 7 while making high the SUTOIKI ratio at the time of a low loading condition, as shown in drawing 6 . A control unit 18 memorizes a table as shown in the interior at drawing 6 and drawing 7 , recognizes a SUTOIKI ratio and a dew-point with reference to a table based on the sensor signal from the condition sensor 17, and controls the hydrogen pressure regulating valve 3, a compressor 6, or the pure water pump 13 for humidification.
[0055] Thereby, by the 2nd dew-point control processing, if a SUTOIKI ratio is made high, while the rate of the amount of hydrogen consumed to the supplied amount of hydrogen decreases, by air pole 1b, it responds to the rate of the amount of produced water to the supplied air content decreasing, and the rate of moisture to distributed gas falling within the fuel cell stack 1, and becoming easy to dry the polyelectrolyte film at hydrogen pole 1a.
[0056] Therefore, according to the fuel cell system equipped with the control unit 18 which performs the 2nd dew-point control processing When the fuel cell stack 1 is in a low loading condition, while enlarging the rate of flow in oxidant gas and/or the fuel cell of fuel gas and being able to control water remaining Desiccation of the electrolyte membrane by having enlarged the rate of flow of oxidant gas and/or fuel gas can be prevented, and desiccation prevention and water remaining prevention of the polyelectrolyte film can more certainly be reconciled as compared with the 1st dew-point control processing.
[0057] Based on the temperature of the fuel cell stack 1, the dew-point of

hydrogen gas and/or air is controlled by the 3rd dew-point control processing of "the 3rd dew-point control processing." Here, as temperature of the fuel cell stack 1, the circulating water temperature near the inflow of cooling water of the fuel cell stack 1 is used, for example. A control unit 18 inputs the sensor signal which shows the temperature of the fuel cell stack 1 from the condition sensor 17, with reference to a table as shown in drawing 8 memorized beforehand, makes low the dew-point of air and/or hydrogen gas, and makes a difference with the dew-point of the temperature of the fuel cell stack 1, hydrogen gas, and/or air large in the negative direction, so that the temperature of the fuel cell stack 1 is low.
[0058] Thereby, since there is little change of the maximum vapor tension to change of a dew-point as shown in drawing 4 when the temperature of the fuel cell stack 1 is low, the rate of a moisture content to the hydrogen capacity and the air content in hydrogen pole 1a and air pole 1b of the fuel cell stack 1 increases, and it can respond to more moisture condensing.
[0059] In the 4th dew-point control processing of "the 4th dew-point control processing" As shown in drawing 9 , the air bypass passage L12 which bypasses air pole 1b is established in the hydrogen bypass passage L11 which bypasses hydrogen pole 1a to the hydrogen gas supply passage L1, and the air supply passage L3. In the fuel cell system which formed the air bypass valve 22 in the hydrogen bypass passage L11 in the hydrogen bypass valve 21 and the air bypass passage L12, the dew-point of hydrogen gas and/or air is separately controlled by the control unit 18. At this time, a control unit 18 controls a dew-point by hydrogen gas and air separately by controlling separately the opening of the hydrogen bypass valve 21 which is a variable-aperture valve, and an air bypass valve 22. At this time, a control unit 18 controls the rate of the hydrogen capacity which passes a humidifier 5, and the hydrogen capacity which does not pass a humidifier 5, and the rate of the air content which passes a humidifier 5, and the air content which does not pass a humidifier 5.
[0060] When performing the 4th dew-point control processing, a control unit 18 With reference to a table as shown in drawing 10 memorized beforehand, when the temperature of the fuel cell stack 1 is lower than the predetermined temperature T, the dew-point of air is made lower than the dew-point of hydrogen gas. When the temperature of the fuel cell stack 1 is higher than the predetermined temperature T, the opening of the hydrogen bypass valve 21 and an air bypass valve 22 is controlled to make the dew-point of air higher than the dew-point of hydrogen gas.
[0061] Only in consideration of condensation of the moisture which a moisture content did not increase at an internal reaction about hydrogen pole 1a, and was introduced by humidification with a humidifier 5 by this, the dew-point in consideration of the moisture generated by the moisture and reaction which were introduced by humidification with a humidifier 5 is controlled about an air pole.
[0062] Since saturated water vapor pressure is low when the temperature of the fuel cell stack 1 is low, the moisture content introduced into hydrogen pole 1a and air pole 1b from a humidifier 5 is small, and produced water and the water of condensation pile up by water-of-condensation and air pole 1b at hydrogen pole 1a. Therefore, the 4th dew-point control processing which controls the hydrogen

bypass valve 21 and an air bypass valve 22 by the control unit 18 to make the dew-point of air lower than the dew-point of hydrogen gas is carried out.
[0063] When the temperature of the fuel cell stack 1 is high, moisture required for hydrogen gas and the fuel cell stack 1 of air in order not to dry the polyelectrolyte film increases, and the moisture content supplied to the fuel cell stack 1 from a humidifier 5 increases. In this case, at hydrogen pole 1a, the rate of a moisture content to internal capacity becomes high by hydrogen consumption by the reaction, and in air pole 1b, although produced water piles up, since the nitrogen which does not react into air is included in large quantities, the rate of a moisture content to internal capacity becomes less than hydrogen pole 1a. Therefore, a control unit 18 carries out the 4th dew-point control processing which controls the hydrogen bypass valve 21 and an air bypass valve 22 to make the dew-point of air higher than the dew-point of hydrogen gas.
[0064] According to the fuel cell system equipped with the control unit 18 which performs such 4th dew-point control processing, a dew-point is controllable independently by hydrogen gas and air by having the hydrogen bypass valve 21 and an air bypass valve 22. Therefore, according to this fuel cell system, the dew-point based on the difference of the amount of drops which piles up by hydrogen pole 1a and air pole 1b can be controlled, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled to every hydrogen pole 1a and air pole 1b, and the generation-of-electrical-energy capacity of a fuel cell can be optimized. Furthermore, according to this fuel cell system, as compared with the case where it considers as the amount of drives of the same pure water pump 13 for humidification, control of the pure-water consumption for humidification is realizable in the time of a heavy load condition and a low loading condition.
[0065] In addition, although this 4th dew-point control processing explained an example which controls independently the dew-point of hydrogen gas and/or air according to the temperature of the fuel cell stack 1, the same effectiveness can be demonstrated even if it controls independently the dew-point of hydrogen gas and/or air based on the load of the fuel cell stack 1.
[0066] Moreover, by this 4th dew-point control processing, while establishing the hydrogen bypass passage L11 in the hydrogen gas supply passage L1, an example which establishes the air bypass passage L12 in the air supply passage L3 was explained, but even if it is the case where bypass passage is prepared for any of the hydrogen gas supply passage L1 and the air supply passage L3 being, the same effectiveness as **** can be acquired.
[0067] In addition, the gestalt of above-mentioned operation is an example of this invention. For this reason, if this invention is range which does not deviate from the technical thought concerning this invention even if it is not limited to an above-mentioned operation gestalt and is except the gestalt of this operation, it is natural. [ of various modification being possible according to a design etc. ]
[0068] Moreover, although the above-mentioned fuel cell system explained the case where poured pure water to the semipermeable membrane in a humidifier 5, and hydrogen gas and/or air were humidified, you may make it inject not only this but pure water in the hydrogen gas supply passage L1 and the air supply passage

L3. At this time, it faces controlling the dew-point of hydrogen gas and/or air, and the same dew-point control processing as **** can be carried out at a control unit 18 by controlling the injection quantity in the hydrogen gas supply passage L1 and/or the air supply passage L3.

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[Translation done.]

## TECHNICAL FIELD

[Field of the Invention] This invention is used as driving sources, such as an automobile, and relates to the control unit of the fuel cell system which faces driving a fuel cell in detail about the control unit of the fuel cell system which drives the fuel cell which generates electricity by supplying air as hydrogen gas and oxidant gas as fuel gas, and controls the dew-point of air and/or hydrogen gas.

[Translation done.]

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## PRIOR ART

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[Description of the Prior Art] As a conventional fuel cell system, what used the so-called fuel cell stack is known as a source of a generation of electrical energy. It comes to carry out two or more laminatings of the fuel cell structure which the fuel cell stack consisted of on both sides of the solid-state polyelectrolyte film with the oxidizer pole and the fuel electrode through a separator. As a fuel cell system using such a fuel cell stack, what is indicated, for example by JP,10-255828,A is known.
[0003] By the fuel cell system currently indicated by this JP,10-255828,A, the polymer electrolyte fuel cell which operates at low temperature comparatively is explained by by supplying hydrogen as air and a fuel as an oxidizer. Moreover, in this conventional fuel cell system, it made it face that a fuel cell generated electricity, and since it was necessary to maintain in the condition of fully carrying out humidity of the solid-state polyelectrolyte film, actuation which humidifies the air and hydrogen which are supplied to a fuel cell using pure water was carried out.

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[Translation done.]

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## EFFECT OF THE INVENTION

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[Effect of the Invention] Since a gas humidification means is controlled to control one [ at least ] dew-point of the oxidant gas supplied to a fuel cell, and fuel gas according to invention concerning claim 1, while being able to control at the optimal dew-point, being able to supply oxidant gas or fuel gas to a fuel cell, maintaining the damp or wet condition of an electrolyte membrane good and optimizing the generation-of-electrical-energy capacity of a fuel cell, control of the pure-water consumption for humidification and prevention of water remaining can be carried out. That is, irrespective of the operational status of a fuel cell, by maintaining the damp or wet condition of an electrolyte membrane good, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled, the generation-of-electrical-energy capacity of a fuel cell can be optimized, and, according to invention concerning claim 1, control of the pure-water consumption for humidification can be further realized in the time of a heavy load condition and a low loading condition as compared with the case where it considers as the same dew-point.
[0019] Since according to invention concerning claim 2 the dew-point of oxidant gas and/or fuel gas is made higher than the time of the 1st predetermined load when it is in a heavy load condition higher than the 1st predetermined load, desiccation of the electrolyte membrane which is easy to generate in the heavy load condition of a fuel cell can be prevented.
[0020] When a generation-of-electrical-energy condition is in a low loading condition lower than the 2nd predetermined load set as the value lower than the predetermined load of the above 1st according to invention concerning claim 3 While making higher than the time of the predetermined load of the above 2nd the ratio of the oxidant gas supplied to the generation-of-electrical-energy condition of a fuel cell, and/or fuel gas Since the dew-point of oxidant gas and/or fuel gas is made higher than the time of a predetermined load While enlarging the rate of flow in oxidant gas and/or the fuel cell of fuel gas and being able to control water remaining Desiccation of the electrolyte membrane by having enlarged the rate of flow of oxidant gas and/or fuel gas can be prevented, and desiccation prevention and water remaining prevention of an electrolyte membrane can more certainly be reconciled as compared with invention concerning claim 1 and claim 2.
[0021] Since according to invention concerning claim 4 the flow rate of the cooling medium supplied to humidification medium passage is controlled and the dew-point

of oxidant gas and/or fuel gas is controlled, while being able to control at the optimal dew-point, being able to supply oxidant gas or fuel gas to a fuel cell, maintaining the damp or wet condition of an electrolyte membrane good and optimizing the generation-of-electrical-energy capacity of a fuel cell, it is realizable to prevent control of the pure-water consumption for humidification and water remaining.
[0022] Since according to invention concerning claim 5 the rate of the quantity of gas flow which passes a gas humidification means, and the quantity of gas flow which passes through detour passage is adjusted and the dew-point of oxidant gas and/or fuel gas is controlled, a dew-point is controllable independently by oxidant gas and fuel gas by having detour passage. Therefore, according to invention concerning this claim 5, as compared with invention concerning claim 1 - claim 3, further, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled, and the generation-of-electrical-energy capacity of a fuel cell can be optimized. Furthermore, according to invention concerning this claim 5, control of the pure-water consumption for humidification is realizable.
[0023] Since one [ at least ] dew-point of the oxidant gas supplied to a fuel cell by the gas supply means and fuel gas is controlled according to the temperature of a fuel cell according to invention concerning claim 6, while being able to control at the optimal dew-point, being able to supply oxidant gas or fuel gas to a fuel cell, maintaining the damp or wet condition of an electrolyte membrane good and optimizing the generation-of-electrical-energy capacity of a fuel cell, control of the pure-water consumption for humidification and water remaining can be prevented. That is, irrespective of the operational status of a fuel cell, by maintaining the damp or wet condition of an electrolyte membrane good, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled, the generation-of-electrical-energy capacity of a fuel cell can be optimized, and, according to invention concerning claim 6, control of the pure-water consumption for humidification can be further realized in the time of a heavy load condition and a low loading condition as compared with the case where it considers as the same dew-point.
[0024] Since according to invention concerning claim 7 the dew-point of oxidant gas and/or fuel gas is made low and there is so little change of the maximum vapor tension to change of a dew-point that the temperature of a fuel cell is low when the temperature of a fuel cell is low, the rate of a moisture content to the amount of fuel gas and the amount of oxidant gas in the fuel electrode and oxidizer pole of a fuel cell increases, and it can respond to more moisture condensing.
[0025] According to invention concerning claim 8, since the dew-point of oxidant gas is made higher than the dew-point of fuel gas when the temperature of a fuel cell is higher than predetermined temperature, the desiccation prevention of an electrolyte membrane and the generating prevention of water remaining in an oxidizer pole are realizable.
[0026] According to invention concerning claim 9, since the dew-point of oxidant gas is made lower than the dew-point of fuel gas when the temperature of a fuel cell is lower than predetermined temperature, the water remaining generating

prevention in an oxidizer pole is realizable.
[0027] Since according to invention concerning claim 10 the flow rate of the cooling medium supplied to humidification medium passage is controlled and the dew-point of oxidant gas and/or fuel gas is controlled, while being able to control at the optimal dew-point, being able to supply oxidant gas or fuel gas to a fuel cell, maintaining the damp or wet condition of an electrolyte membrane good and optimizing the generation-of-electrical-energy capacity of a fuel cell, it is realizable to prevent control of the pure-water consumption for humidification and water remaining.
[0028] Since according to invention concerning claim 11 the rate of the quantity of gas flow which passes a gas humidification means, and the quantity of gas flow which passes through detour passage is adjusted and the dew-point of oxidant gas and/or fuel gas is controlled, a dew-point is controllable independently by oxidant gas and fuel gas by having detour passage. Therefore, according to invention concerning this claim 5, as compared with invention concerning claim 1 - claim 3, further, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled, and the generation-of-electrical-energy capacity of a fuel cell can be optimized. Furthermore, according to invention concerning this claim 5, control of the pure-water consumption for humidification is realizable.
[0029]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing.
[0030] This invention is applied to the fuel cell system constituted as shown in drawing 1 .
[0031] The [fuel cell structure of a system] This fuel cell system is equipped with the fuel cell stack 1 which hydrogen content gas and fuel gas are supplied, and is generated. This fuel cell stack 1 consists of two or more fuel cell structures which ****(ed) with the separator the fuel cell structure which opposite-**(ed) the fuel electrode (hydrogen pole 1a) and the oxidizer pole (air pole 1b) for example, on both sides of the solid-state polyelectrolyte film. This fuel cell stack 1 generates electricity by hydrogen gas being supplied to the hydrogen pole 1a side as fuel gas, for example, is used as driving sources, such as an automobile, while air is supplied to the air pole 1b side as oxidant gas.
[0032] A fuel cell system is equipped with the hydrogen gas supply passage L1 which supplies it to the fuel cell stack 1 through an ejector pump 4 and a humidifier 5 after regulating the pressure of the hydrogen gas stored in the hydrogen tank 2 with the hydrogen pressure regulating valve 3.
[0033] The hydrogen pressure regulating valve 3 is carrying out a switching action according to the control signal from a control unit 18, and adjusts the pressure of the hydrogen gas within a fuel cell system. The humidifier 5 has the composition of passing pure water, in the semipermeable membrane fabricated for example, in the shape of a pipe, is contacting the air from the hydrogen gas and the compressor 6 from an ejector pump 4 to semipermeable membrane, and has composition which carries out humidification of the hydrogen gas and air through semipermeable membrane.

[0034] Moreover, this fuel cell system is equipped with the hydrogen gas circulating flow way L2 which supplies the exhaust gas used as the hydrogen gas from the hydrogen pole 1a side, and the mixed gas of a steam to an ejector pump 4, and supplies it to the fuel cell stack 1 through a humidifier 5 again.
[0035] Furthermore, this fuel cell system is equipped with the air supply passage L3 which supplies the air from the outside to the fuel cell stack 1 through a compressor 6 and a humidifier 5. A compressor 6 supplies the air of the flow rate which followed the control signal from the control unit 18 to the fuel cell stack 1 through the air supply passage L3.
[0036] In this fuel cell system, including a steam and liquid hydrogen, it is separated into a part for liquid hydrogen, and a steam by the water separator 7, and a part for liquid hydrogen is stored in a demineralised water tank 8, and the exhaust gas by the side of air pole 1b from the fuel cell stack 1 is constituted so that a steam may be discharged outside through the air pressure regulating valve 9. The air pressure regulating valve 9 adjusts the pressure of the air within a fuel cell system by carrying out a switching action according to the control signal from a control unit 18.
[0037] Furthermore, this fuel cell system is further equipped with the pure-water circulating flow way L5 which circulates the cooling water circulating flow way L4 which circulates cooling water in the fuel cell stack 1, and the pure water for humidifying the hydrogen gas and fuel gas which are supplied at the fuel cell stack 1 again. The intermediate heat exchanger 11 which carries out heat exchange between cooling water and pure water is arranged in this cooling water circulating flow way L4 and the pure-water circulating flow way L5.
[0038] The cooling water pump 10, the heat exchanger 11, and the radiator 12 are arranged in this cooling water circulating flow way L4. Cooling water is made to flow in the fuel cell stack 1, it cools with a radiator 12 and a cooling water pump 10 is made to circulate through the cooling water which was made to carry out heat exchange between the pure water of the pure-water circulating flow way L5 by intermediate heat exchanger 11, and became high temperature by generation of heat of the fuel cell stack 1 about the cooling water from the fuel cell stack 1 by driving a cooling water pump 10 in this fuel cell system. Thereby, a fuel cell system maintains the fuel cell stack 1 to predetermined temperature with cooling water.
[0039] The pure water pump 13 for humidification which leads the pure water accumulated in the demineralised water tank 8 to a humidifier 5, and intermediate heat exchanger 11 are arranged in the pure-water circulating flow way L5. In this fuel cell system, by driving the pure water pump 13 for humidification, the pure water accumulated in the demineralised water tank 8 is supplied to intermediate heat exchanger 11, carry out heat exchange of the pure water between cooling water, it is made to heat, and a humidifier 5 is supplied. Thereby, within a humidifier 5, pure water is supplied, for example in a pipe-like semi-transparent membrane, and when hydrogen gas and air pass to a semi-transparent membrane, it humidifies to hydrogen gas and air.
[0040] Furthermore, it has the air flow rate sensor 14 which is prepared in the preceding paragraph of a compressor 6 and detects the flow rate of air in a fuel cell system, the hydrogen pressure force sensor 15 which detects the pressure of

the hydrogen gas supplied to the fuel cell stack 1, the air-pressure sensor 16 which detects the pressure of the air supplied to the fuel cell stack 1, and the condition sensor 17 which is connected with the fuel cell stack 1 and detects the generation-of-electrical-energy condition or the temperature of the fuel cell stack 1. Each sensors 14-17 supply the sensor signal detected and acquired to a control unit 18.

[0041] A control unit 18 outputs the control signal which controls each part of a fuel cell system based on the sensor signal from each sensors 14-17. A control unit 18 carries out dew-point control processing which controls the dew-point of the hydrogen gas supplied to the fuel cell stack 1, and/or air according to the condition of the fuel cell stack 1.

[0042] The 1st dew-point control processing by the control unit 18 - the 4th dew-point control processing are explained as actuation of an above-mentioned fuel cell system below [actuation of a fuel cell system].

[0043] In the 1st dew-point control processing of "the 1st dew-point control processing", a control unit 18 makes high the dew-point of hydrogen gas and/or air, when the ejection current (load) from the fuel cell stack 1 is large. At this time, a control unit 18 recognizes the generation-of-electrical-energy condition of the fuel cell stack 1, i.e., the load of the fuel cell stack 1, based on a sensor signal from the condition sensor 17, as it makes a dew-point high according to the magnitude of a load, it makes [ many ] the amount of drives of the pure water pump 13 for humidification, and it carries out control which supplies many pure-water flow rates to a humidifier 5.

[0044] Here, in hydrogen pole 1a of the fuel cell stack 1, hydrogen is consumed by the reaction (H2 ->2H++2e-), and water is generated by the reaction of the oxygen contained in air in air pole 1b, and the hydrogen (2H+) from hydrogen pole 1a (1/2O2+2H++2e-->H2O). Especially if the dew-point of air and hydrogen gas is too low, the polyelectrolyte film will dry in near a gas inlet, and it will become decline in generating efficiency, and promotion of degradation of an electrolyte membrane. On the contrary, if the dew-point of air and hydrogen gas is too high, in order that a lot of liquid hydrogen may condense in the fuel cell stack 1, it becomes easy to generate water remaining. On the other hand, in a control unit 18, the above-mentioned 1st dew-point control processing is carried out.

[0045] Moreover, on the property of the fuel cell stack 1, the temperature gradient of the circulating water temperature in the outflow of cooling water of the fuel cell stack 1 and the circulating water temperature in the inflow of cooling water of the fuel cell stack 1 becomes large, so that the ejection current from the fuel cell stack 1 is large, since the ejection current from the fuel cell stack 1 is large, namely, the calorific value of the fuel cell stack 1 becomes large so that it is a heavy load as shown in drawing 3 . For this reason, the mean temperature of the fuel cell stack 1 becomes high, so that the ejection current from the fuel cell stack 1 is large.

[0046] Furthermore, maximum vapor tension increases the fuel cell stack 1 rapidly, so that the dew-point of hydrogen gas and/or air becomes high, as shown in drawing 4 .

[0047] From drawing 3 and drawing 4 , it is shown that the saturated water vapor

pressure within the fuel cell stack 1 increases, and it is hard to condense a part for liquid hydrogen, so that the fuel cell stack 1 is in a heavy load condition. Therefore, in order to prevent desiccation of the polyelectrolyte film, a control unit 18 controls highly the dew-point of the air in the outlet of a humidifier 5, and/or hydrogen gas with reference to a table as shown in drawing 5 , when the fuel cell stack 1 is in a heavy load condition. The table shown in drawing 5 shows relation with the dew-point of the hydrogen gas supplied to the fuel cell stack 1, and/or air from the pure-water flow rate passed in a humidifier 5, and a humidifier 5, and the amount control of drives of the pure water pump 13 for humidification based on the dew-point required of the fuel cell stack 1 by the control unit 18 is carried out.

[0048] It is made lower [ if control made into the dew-point as a heavy load condition when a control unit 18 is the same when the fuel cell stack 1 is in a low loading condition is carried out, will not generate desiccation of the polyelectrolyte film, but ] than the dew-point at the time of a heavy load condition, since the condensation rate for liquid hydrogen increases and it becomes easy to generate water remaining here.

[0049] According to the fuel cell system equipped with the control unit 18 which carries out this 1st dew-point control processing, the amount of drives of the pure water pump 13 for humidification is enlarged, desiccation of an electrolyte membrane is prevented so that the dew-point of hydrogen gas and/or air may be made high in a heavy load condition, the amount of drives of the pure water pump 13 for humidification is made small, and generating of water remaining is prevented so that it may be made lower than the dew-point at the time of a heavy load condition in a low loading condition.

[0050] Therefore, irrespective of the operational status of the fuel cell stack 1, by maintaining the damp or wet condition of an electrolyte membrane good, the generating efficiency fall by desiccation of the polyelectrolyte film or water remaining can be controlled, and, according to this fuel cell system, the generation-of-electrical-energy capacity of a fuel cell can be optimized. Furthermore, according to this fuel cell system, as compared with the case where it considers as the amount of drives of the same pure water pump 13 for humidification, control of the pure-water consumption for humidification is realizable in the time of a heavy load condition and a low loading condition.

[0051] In addition, the field between the 1st above-mentioned predetermined load and the 2nd predetermined load means an inside load field among the operating range of a fuel cell.

[0052] In the 2nd dew-point control processing of "the 2nd dew-point control processing", control corresponding to being easy to generate according to the rate of flow of distributed gas being slow, namely, being easy to generate water remaining in a low loading condition with little gas supply volume to the fuel cell stack 1 is carried out.

[0053] In the 2nd dew-point control processing, a control unit 18 controls the hydrogen pressure regulating valve 3 and/or a compressor 6 rather than outside in a low loading condition in the low loading condition of the fuel cell stack 1 to make a SUTOIKI ratio (SR) high. Here, a SUTOIKI ratio is a ratio of the amount of

distributed gas to the amount of reactant gas within the fuel cell stack 1, and it is controlled by the normal state by the bigger value than "1."
[0054] Moreover, in this 2nd dew-point control processing, a control unit 18 carries out control which makes high the dew-point at the time of a low loading condition as shown in drawing 7 while making high the SUTOIKI ratio at the time of a low loading condition, as shown in drawing 6 . A control unit 18 memorizes a table as shown in the interior at drawing 6 and drawing 7 , recognizes a SUTOIKI ratio and a dew-point with reference to a table based on the sensor signal from the condition sensor 17, and controls the hydrogen pressure regulating valve 3, a compressor 6, or the pure water pump 13 for humidification.
[0055] Thereby, by the 2nd dew-point control processing, if a SUTOIKI ratio is made high, while the rate of the amount of hydrogen consumed to the supplied amount of hydrogen decreases, by air pole 1b, it responds to the rate of the amount of produced water to the supplied air content decreasing, and the rate of moisture to distributed gas falling within the fuel cell stack 1, and becoming easy to dry the polyelectrolyte film at hydrogen pole 1a.
[0056] Therefore, according to the fuel cell system equipped with the control unit 18 which performs the 2nd dew-point control processing When the fuel cell stack 1 is in a low loading condition, while enlarging the rate of flow in oxidant gas and/or the fuel cell of fuel gas and being able to control water remaining Desiccation of the electrolyte membrane by having enlarged the rate of flow of oxidant gas and/or fuel gas can be prevented, and desiccation prevention and water remaining prevention of the polyelectrolyte film can more certainly be reconciled as compared with the 1st dew-point control processing.
[0057] Based on the temperature of the fuel cell stack 1, the dew-point of hydrogen gas and/or air is controlled by the 3rd dew-point control processing of "the 3rd dew-point control processing." Here, as temperature of the fuel cell stack 1, the circulating water temperature near the inflow of cooling water of the fuel cell stack 1 is used, for example. A control unit 18 inputs the sensor signal which shows the temperature of the fuel cell stack 1 from the condition sensor 17, with reference to a table as shown in drawing 8 memorized beforehand, makes low the dew-point of air and/or hydrogen gas, and makes a difference with the dew-point of the temperature of the fuel cell stack 1, hydrogen gas, and/or air large in the negative direction, so that the temperature of the fuel cell stack 1 is low.
[0058] Thereby, since there is little change of the maximum vapor tension to change of a dew-point as shown in drawing 4 when the temperature of the fuel cell stack 1 is low, the rate of a moisture content to the hydrogen capacity and the air content in hydrogen pole 1a and air pole 1b of the fuel cell stack 1 increases, and it can respond to more moisture condensing.
[0059] In the 4th dew-point control processing of "the 4th dew-point control processing" As shown in drawing 9 , the air bypass passage L12 which bypasses air pole 1b is established in the hydrogen bypass passage L11 which bypasses hydrogen pole 1a to the hydrogen gas supply passage L1, and the air supply passage L3. In the fuel cell system which formed the air bypass valve 22 in the hydrogen bypass passage L11 in the hydrogen bypass valve 21 and the air bypass passage L12, the dew-point of hydrogen gas and/or air is separately controlled by

the control unit 18. At this time, a control unit 18 controls a dew-point by hydrogen gas and air separately by controlling separately the opening of the hydrogen bypass valve 21 which is a variable-aperture valve, and an air bypass valve 22. At this time, a control unit 18 controls the rate of the hydrogen capacity which passes a humidifier 5, and the hydrogen capacity which does not pass a humidifier 5, and the rate of the air content which passes a humidifier 5, and the air content which does not pass a humidifier 5.

[0060] When performing the 4th dew-point control processing, a control unit 18 With reference to a table as shown in drawing 10 memorized beforehand, when the temperature of the fuel cell stack 1 is lower than the predetermined temperature T, the dew-point of air is made lower than the dew-point of hydrogen gas. When the temperature of the fuel cell stack 1 is higher than the predetermined temperature T, the opening of the hydrogen bypass valve 21 and an air bypass valve 22 is controlled to make the dew-point of air higher than the dew-point of hydrogen gas.

[0061] Only in consideration of condensation of the moisture which a moisture content did not increase at an internal reaction about hydrogen pole 1a, and was introduced by humidification with a humidifier 5 by this, the dew-point in consideration of the moisture generated by the moisture and reaction which were introduced by humidification with a humidifier 5 is controlled about an air pole.

[0062] Since saturated water vapor pressure is low when the temperature of the fuel cell stack 1 is low, the moisture content introduced into hydrogen pole 1a and air pole 1b from a humidifier 5 is small, and produced water and the water of condensation pile up by water-of-condensation and air pole 1b at hydrogen pole 1a. Therefore, the 4th dew-point control processing which controls the hydrogen bypass valve 21 and an air bypass valve 22 by the control unit 18 to make the dew-point of air lower than the dew-point of hydrogen gas is carried out.

[0063] When the temperature of the fuel cell stack 1 is high, moisture required for hydrogen gas and the fuel cell stack 1 of air in order not to dry the polyelectrolyte film increases, and the moisture content supplied to the fuel cell stack 1 from a humidifier 5 increases. In this case, at hydrogen pole 1a, the rate of a moisture content to internal capacity becomes high by hydrogen consumption by the reaction, and in air pole 1b, although produced water piles up, since the nitrogen which does not react into air is included in large quantities, the rate of a moisture content to internal capacity becomes less than hydrogen pole 1a. Therefore, a control unit 18 carries out the 4th dew-point control processing which controls the hydrogen bypass valve 21 and an air bypass valve 22 to make the dew-point of air higher than the dew-point of hydrogen gas.

[0064] According to the fuel cell system equipped with the control unit 18 which performs such 4th dew-point control processing, a dew-point is controllable independently by hydrogen gas and air by having the hydrogen bypass valve 21 and an air bypass valve 22. Therefore, according to this fuel cell system, the dew-point based on the difference of the amount of drops which piles up by hydrogen pole 1a and air pole 1b can be controlled, the generating efficiency fall by desiccation of an electrolyte membrane or water remaining can be controlled to every hydrogen pole 1a and air pole 1b, and the generation-of-electrical-energy capacity of a fuel cell

can be optimized. Furthermore, according to this fuel cell system, as compared with the case where it considers as the amount of drives of the same pure water pump 13 for humidification, control of the pure-water consumption for humidification is realizable in the time of a heavy load condition and a low loading condition.

[0065] In addition, although this 4th dew-point control processing explained an example which controls independently the dew-point of hydrogen gas and/or air according to the temperature of the fuel cell stack 1, the same effectiveness can be demonstrated even if it controls independently the dew-point of hydrogen gas and/or air based on the load of the fuel cell stack 1.

[0066] Moreover, by this 4th dew-point control processing, while establishing the hydrogen bypass passage L11 in the hydrogen gas supply passage L1, an example which establishes the air bypass passage L12 in the air supply passage L3 was explained, but even if it is the case where bypass passage is prepared for any of the hydrogen gas supply passage L1 and the air supply passage L3 being, the same effectiveness as **** can be acquired.

[0067] In addition, the gestalt of above-mentioned operation is an example of this invention. For this reason, if this invention is range which does not deviate from the technical thought concerning this invention even if it is not limited to an above-mentioned operation gestalt and is except the gestalt of this operation, it is natural. [ of various modification being possible according to a design etc. ]

[0068] Moreover, although the above-mentioned fuel cell system explained the case where poured pure water to the semipermeable membrane in a humidifier 5, and hydrogen gas and/or air were humidified, you may make it inject not only this but pure water in the hydrogen gas supply passage L1 and the air supply passage L3. At this time, it faces controlling the dew-point of hydrogen gas and/or air, and the same dew-point control processing as **** can be carried out at a control unit 18 by controlling the injection quantity in the hydrogen gas supply passage L1 and/or the air supply passage L3.

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[Translation done.]

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## TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention] However, in said conventional fuel cell system, it faces carrying out humidity of the solid-state polyelectrolyte film, and if there are too few amounts of humidification to the oxidant gas and/or fuel gas (it is only hereafter called the "distributed gas".) which are supplied to a fuel cell, an electrolyte membrane will dry, and the problem that sufficient generated output cannot be obtained occurs.
[0005] On the other hand, in the conventional fuel cell system, when there are too many amounts of humidification to distributed gas, the consumption of the pure water used as an object for humidification may increase, or the amount of water of condensation in a fuel cell may increase. The water remaining in which the water of condensation becomes is hard to be discharged from the inside of a fuel cell when it comes to such a condition, and a lot of water piles up occurs, sufficient generated output may be unable to be obtained and the problem which promotes degradation of the component part of a fuel cell further occurs.
[0006] Then, this invention is proposed in view of the problem mentioned above, and it offers control of the pure-water consumption for humidification, and the control unit of the fuel cell system which can prevent water remaining while it maintains the damp or wet condition of an electrolyte membrane good and optimizes the generation-of-electrical-energy capacity of a fuel cell.

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[Translation done.]

## MEANS

[Means for Solving the Problem] In order to solve an above-mentioned technical problem, in invention concerning claim 1 While being constituted by an oxidizer pole and the fuel electrode on both sides of an electrolyte membrane and supplying oxidant gas to the above-mentioned oxidizer pole side The fuel cell which fuel gas is supplied to the above-mentioned fuel electrode side, and is generated, and a gas supply means to supply oxidant gas and fuel gas to the above-mentioned fuel cell, In the control unit of the fuel cell system which controls the fuel cell system equipped with a gas humidification means to humidify the oxidant gas and fuel gas which are supplied to the above-mentioned fuel cell by the above-mentioned gas supply means The generation-of-electrical-energy condition detected with a generation-of-electrical-energy condition detection means to detect the generation-of-electrical-energy condition of the above-mentioned fuel cell, and the above-mentioned generation-of-electrical-energy condition detection means is embraced. It has the oxidant gas supplied to the above-mentioned fuel cell by the above-mentioned gas supply means, and the humidification control means which controls the above-mentioned gas humidification means to control one [ at least ] dew-point of fuel gas.
[0008] It is the control unit of a fuel cell system according to claim 1, and the above-mentioned humidification control means controls the above-mentioned gas humidification means by invention concerning claim 2 to make the dew-point of oxidant gas and/or fuel gas higher than the time of the predetermined load of the above 1st, when the generation-of-electrical-energy condition detected by the above-mentioned generation-of-electrical-energy condition detection means is in a heavy load condition higher than the 1st predetermined load.
[0009] In invention concerning claim 3, it is the control unit of a fuel cell system according to claim 1. The above-mentioned humidification control means When the generation-of-electrical-energy condition detected by the above-mentioned generation-of-electrical-energy condition detection means is in a low loading condition lower than the 2nd predetermined load set as the value lower than the predetermined load of the above 1st While controlling the above-mentioned gas supply means to make higher than the time of a predetermined load the ratio of the oxidant gas supplied to the generation-of-electrical-energy condition of the above-mentioned fuel cell, and/or fuel gas, the above-mentioned gas humidification means is controlled to make the dew-point of oxidant gas and/or

fuel gas higher than the time of the predetermined load of the above 2nd.
[0010] It is the control unit of a fuel cell system given in any of claims 1-3 they are, and it has the humidifier style which a humidification medium flows into the humidification medium passage which has semipermeable membrane, and oxidant gas and fuel gas, and a humidification medium contact through the above-mentioned semipermeable membrane, and humidifies oxidant gas and fuel gas, and the above-mentioned humidification control means controls the flow rate of the cooling medium which supplies to the above-mentioned humidification medium passage, and controls the dew-point of the above-mentioned oxidant gas and/or fuel gas by invention concerning claim 4.
[0011] In invention concerning claim 5, it is the control unit of a fuel cell system given in any of claims 1-4 they are. The oxidant gas feeder current way which supplies oxidant gas to the above-mentioned fuel cell from the above-mentioned gas supply means, And/or, the detour passage which is established in the fuel gas feeder current way which supplies fuel gas to the above-mentioned fuel cell from the above-mentioned gas supply means, bypasses the above-mentioned gas humidification means and supplies oxidant gas and/or fuel gas to the above-mentioned fuel cell, A flow control means to adjust the quantity of gas flow which passes through the above-mentioned detour passage, It has further the flow rate control means which controls a flow control means to adjust the rate of the quantity of gas flow which passes the above-mentioned gas humidification means, and the quantity of gas flow which passes through the above-mentioned detour passage, and to control the dew-point of the above-mentioned oxidant gas and/or fuel gas.
[0012] In order to solve an above-mentioned technical problem, in invention concerning claim 6 While being constituted by an oxidizer pole and the fuel electrode on both sides of an electrolyte membrane and supplying oxidant gas to the above-mentioned oxidizer pole side The fuel cell which fuel gas is supplied to the above-mentioned fuel electrode side, and is generated, and a gas supply means to supply oxidant gas and fuel gas to the above-mentioned fuel cell, In the control unit of the fuel cell system which controls the fuel cell system equipped with a gas humidification means to humidify the oxidant gas and fuel gas which are supplied to the above-mentioned fuel cell by the above-mentioned gas supply means The temperature of the above-mentioned fuel cell detected with a temperature detection means to detect the temperature of the above-mentioned fuel cell, and the above-mentioned temperature detection means is embraced. It has the oxidant gas supplied to the above-mentioned fuel cell by the above-mentioned gas supply means, and the dew-point control means which controls the above-mentioned gas humidification means to control one [ at least ] dew-point of fuel gas.
[0013] In invention concerning claim 7, it is the control unit of a fuel cell system according to claim 6, and the above-mentioned dew-point control means makes low the dew-point of the above-mentioned oxidant gas and/or fuel gas, so that the temperature of the above-mentioned fuel cell detected with the above-mentioned temperature detection means is low.
[0014] It is the control unit of a fuel cell system according to claim 6, and the above-mentioned dew-point control means controls the above-mentioned gas

humidification means by invention concerning claim 8 to make the dew-point of oxidant gas higher than the dew-point of fuel gas, when the temperature of the fuel cell detected with the above-mentioned temperature detection means is higher than predetermined temperature.

[0015] It is the control unit of a fuel cell system according to claim 6, and the above-mentioned dew-point control means controls the above-mentioned gas humidification means by invention concerning claim 9 to make the dew-point of oxidant gas lower than the dew-point of fuel gas, when the temperature of the fuel cell detected with the above-mentioned temperature detection means is lower than predetermined temperature.

[0016] In invention concerning claim 10, it is the control unit of a fuel cell system given in any of claims 6-9 they are. The above-mentioned gas humidification means It has the humidifier style which a humidification medium flows into the humidification medium passage which has semipermeable membrane, and oxidant gas and fuel gas, and a humidification medium are contacted through the above-mentioned semipermeable membrane, and humidifies oxidant gas and fuel gas. The above-mentioned humidification control means controls the flow rate of the cooling medium supplied to the above-mentioned humidification medium passage, and controls the dew-point of the above-mentioned oxidant gas and/or fuel gas.

[0017] In invention concerning claim 11, it is the control unit of a fuel cell system given in any of claims 6-10 they are. The oxidant gas feeder current way which supplies oxidant gas to the above-mentioned fuel cell from the above-mentioned gas supply means, And/or, the detour passage which is established in the fuel gas feeder current way which supplies fuel gas to the above-mentioned fuel cell from the above-mentioned gas supply means, bypasses the above-mentioned gas humidification means and supplies oxidant gas and/or fuel gas to the above-mentioned fuel cell, A flow control means to adjust the quantity of gas flow which passes through the above-mentioned detour passage, It has further the flow rate control means which controls a flow control means to adjust the rate of the quantity of gas flow which passes the above-mentioned gas humidification means, and the quantity of gas flow which passes through the above-mentioned detour passage, and to control the dew-point of the above-mentioned oxidant gas and/or fuel gas.

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[Translation done.]

## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the fuel cell structure of a system which applied this invention.
[Drawing 2] It is drawing for explaining the magnitude of the current taken out from a fuel cell stack, and relation with a dew-point.
[Drawing 3] It is drawing for explaining the temperature gradient of the magnitude of the current taken out from a fuel cell stack, and the circulating water temperature in the outflow of cooling water of a fuel cell stack and the circulating water temperature in the inflow of cooling water, and the relation of **.
[Drawing 4] It is drawing for explaining the dew-point of hydrogen gas and air, and relation with saturated water vapor pressure.
[Drawing 5] It is drawing showing relation with the dew-point of the hydrogen gas supplied to a fuel cell stack, and/or air from the pure-water flow rate passed in a humidifier, and a humidifier.
[Drawing 6] It is drawing for explaining the contents of control in the 2nd dew-point control processing, and is drawing showing the relation between the current taken out from a fuel cell stack, and hydrogen gas and/or the SUTOIKI ratio of air.
[Drawing 7] It is drawing for explaining the contents of control in the 2nd dew-point control processing, and is drawing showing the relation between the current taken out from a fuel cell stack, and the dew-point of hydrogen gas and/or air.
[Drawing 8] It is drawing for explaining the contents of control in the 3rd dew-point control processing, and is drawing showing relation with a difference with the dew-point of the temperature of a fuel cell stack, the temperature of a fuel cell stack, hydrogen gas, and/or air.
[Drawing 9] It is an important section block diagram in the fuel cell system in the 4th dew-point control processing.
[Drawing 10] It is drawing for explaining the contents of control in the 4th dew-point control processing, and is drawing showing the relation between the temperature of a fuel cell stack, and the dew-point of hydrogen gas and/or air.
[Description of Notations]
1 Fuel Cell Stack
2 Hydrogen Tank
3 Hydrogen Pressure Regulating Valve
4 Ejector Pump

5 Humidifier
6 Compressor
7 Water Separator
8 Demineralised Water Tank
9 Air Pressure Regulating Valve
10 Cooling Water Pump
11 Intermediate Heat Exchanger
12 Radiator
13 Pure Water Pump for Humidification
14 Air Flow Rate Sensor
15 Hydrogen Pressure Force Sensor
16 Air Pressure Sensor
17 Condition Sensor
18 Control Unit
21 Hydrogen Bypass Valve
22 Air Bypass Valve

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[Translation done.]

* NOTICES *

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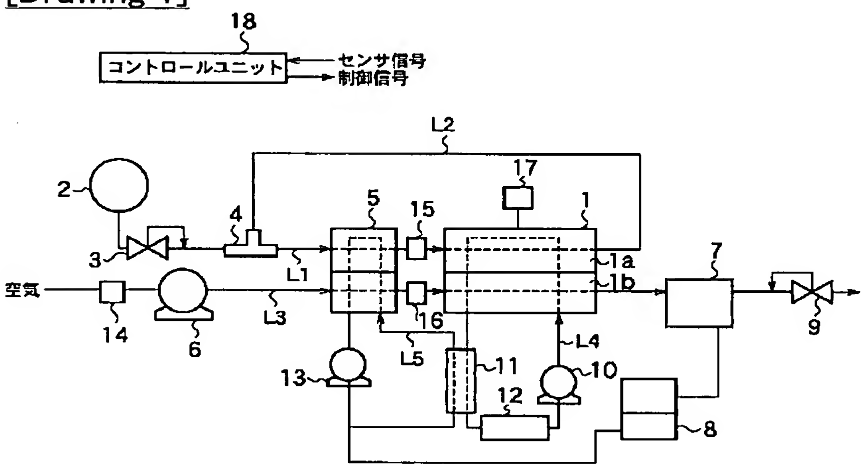
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

## DRAWINGS

[Drawing 1]

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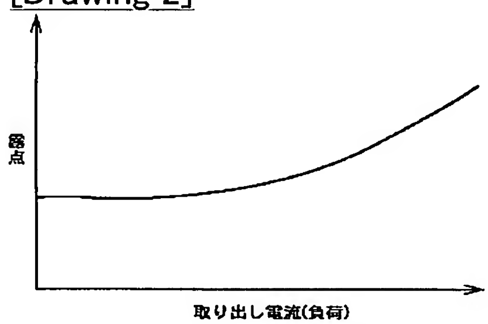


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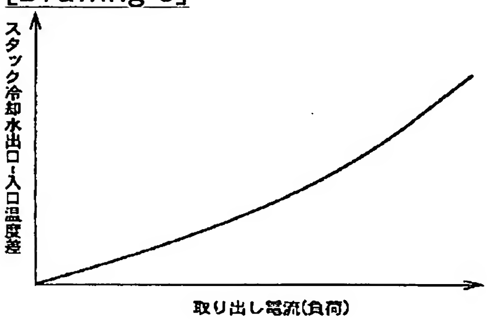
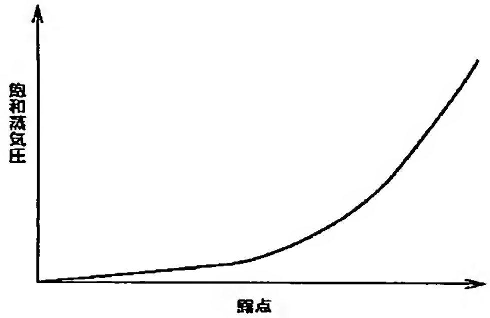



[Drawing 4]

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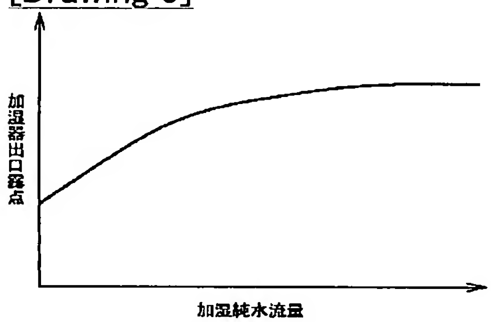
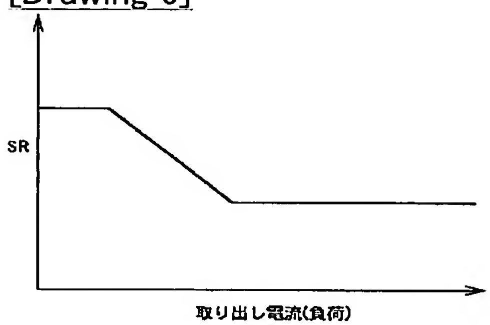
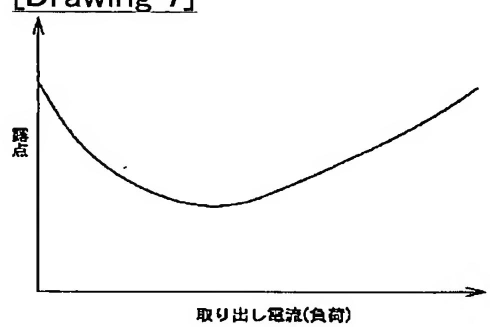


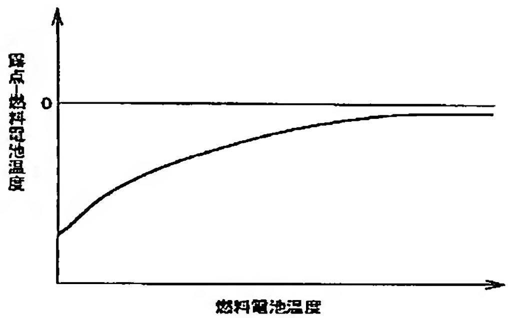

[Drawing 6]



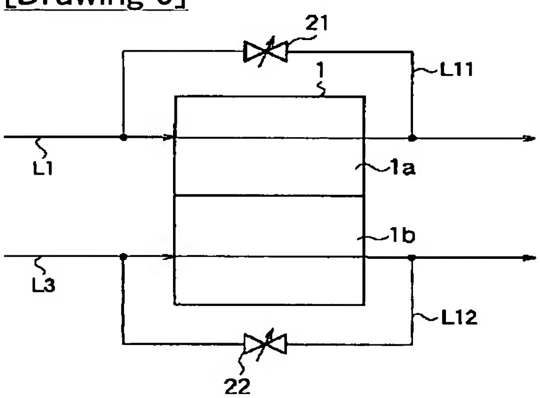

[Drawing 7]



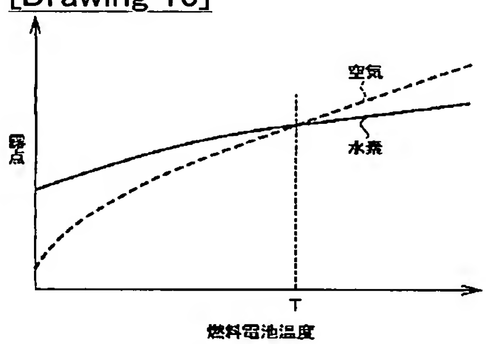

[Drawing 8]




[Drawing 9]




[Drawing 10]

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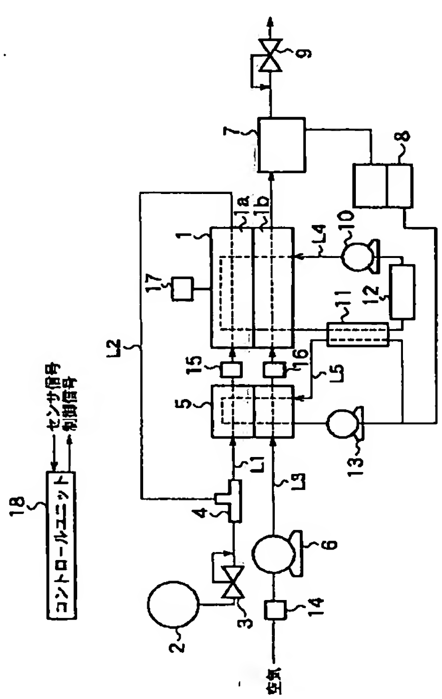
KK56 MM01 MM03 MM04 MM08
MM09 MM16

(54)【発明の名称】　燃料電池システムの制御装置

(57)【要約】
【課題】　電解質膜の湿潤状態を良好に維持して燃料電池の発電能力を最適化すると共に、加湿用純水消費量の抑制、水詰まりを防止する。
【解決手段】　電解質膜を空気極１ｂと水素極１ａとにより挟んで構成した燃料電池スタック１と、燃料電池スタック１に空気及び水素ガスを供給する水素ガス供給流路Ｌ１と、水素ガス供給流路Ｌ１により燃料電池スタック１に供給される空気及び水素ガスを加湿する加湿器５とを備えた燃料電池システムをコントロールユニット１８により制御するものである。コントロールユニット１８は、燃料電池スタック１の発電状態を検出する発電状態検出手段と、上記発電状態検出手段で検出された発電状態に応じて、上記ガス供給手段により上記燃料電池に供給される酸化剤ガス、燃料ガスの少なくとも一方の露点を制御するように上記ガス加湿手段を制御する加湿制御手段とを備える。



【特許請求の範囲】

【請求項１】　電解質膜を酸化剤極と燃料極とにより挟んで構成され、上記酸化剤極側に酸化剤ガスが供給されると共に、上記燃料極側に燃料ガスが供給されて発電する燃料電池と、上記燃料電池に酸化剤ガス及び燃料ガスを供給するガス供給手段と、上記ガス供給手段により上記燃料電池に供給される酸化剤ガス及び燃料ガスを加湿するガス加湿手段とを備えた燃料電池システムを制御する燃料電池システムの制御装置において、
上記燃料電池の発電状態を検出する発電状態検出手段と、
上記発電状態検出手段で検出された発電状態に応じて、上記ガス供給手段により上記燃料電池に供給される酸化剤ガス、燃料ガスの少なくとも一方の露点を制御するように上記ガス加湿手段を制御する加湿制御手段とを備えることを特徴とする燃料電池システムの制御装置。

【請求項２】　上記加湿制御手段は、上記発電状態検出手段により検出された発電状態が、第１の所定負荷よりも高い高負荷状態である時には、酸化剤ガス及び／又は燃料ガスの露点を、上記第１の所定負荷時よりも高くするように上記ガス加湿手段を制御することを特徴とする請求項１記載の燃料電池システムの制御装置。

【請求項３】　上記加湿制御手段は、上記発電状態検出手段により検出された発電状態が、上記第１の所定負荷よりも低い値に設定された第２の所定負荷よりも低い低負荷状態である時には、上記燃料電池の発電状態に対し て供給する酸化剤ガス及び／又は燃料ガスの比を上記第２の所定負荷時よりも高くするように上記ガス供給手段を制御すると共に、酸化剤ガス及び／又は燃料ガスの露点を上記第２の所定負荷時よりも高くするように上記ガス加湿手段を制御することを特徴とする請求項１記載の燃料電池システムの制御装置。

【請求項４】　上記ガス加湿手段は、半透膜を有する加湿媒体流路に加湿媒体が流入され、上記半透膜を介して酸化剤ガス及び燃料ガスと加湿媒体とを接触させて酸化剤ガス及び燃料ガスを加湿する加湿機構を備え、
上記加湿制御手段は、上記加湿媒体流路に供給する冷却媒体の流量を制御して上記酸化剤ガス及び／又は燃料ガスの露点を制御することを特徴とする請求項１～３の何れかに記載の燃料電池システムの制御装置。

【請求項５】　上記ガス供給手段から上記燃料電池に酸化剤ガスを供給する酸化剤ガス供給流路、及び／又は上記ガス供給手段から上記燃料電池に燃料ガスを供給する燃料ガス供給流路に設けられ、酸化剤ガス及び／又は燃料ガスを上記ガス加湿手段を迂回して上記燃料電池に供給する迂回流路と、
上記迂回流路を通過するガス流量を調整する流量調整手段と、
上記ガス加湿手段を通過するガス流量と上記迂回流路を通過するガス流量の割合を調整して上記酸化剤ガス及び／又は燃料ガスの露点を制御するように流量調整手段を制御する流量制御手段とを更に備えることを特徴とする請求項１～４の何れかに記載の燃料電池システムの制御装置。

【請求項６】　電解質膜を酸化剤極と燃料極とにより挟んで構成され、上記酸化剤極側に酸化剤ガスが供給されると共に、上記燃料極側に燃料ガスが供給されて発電する燃料電池と、上記燃料電池に酸化剤ガス及び燃料ガスを供給するガス供給手段と、上記ガス供給手段により上記燃料電池に供給される酸化剤ガス及び燃料ガスを加湿するガス加湿手段とを備えた燃料電池システムを制御する燃料電池システムの制御装置において、
上記燃料電池の温度を検出する温度検出手段と、
上記温度検出手段で検出された上記燃料電池の温度に応じて、上記ガス供給手段により上記燃料電池に供給される酸化剤ガス、燃料ガスの少なくとも一方の露点を制御するように上記ガス加湿手段を制御する露点制御手段とを備えることを特徴とする燃料電池システムの制御装置。

【請求項７】　上記露点制御手段は、上記温度検出手段で検出された上記燃料電池の温度が低いほど、上記酸化剤ガス及び／又は燃料ガスの露点を低くすることを特徴とする請求項６記載の燃料電池システムの制御装置。

【請求項８】　上記露点制御手段は、上記温度検出手段で検出された燃料電池の温度が所定温度よりも高いときには、酸化剤ガスの露点を燃料ガスの露点よりも高くするように上記ガス加湿手段を制御することを特徴とする請求項６記載の燃料電池システムの制御装置。

【請求項９】　上記露点制御手段は、上記温度検出手段で検出された燃料電池の温度が所定温度よりも低いときには、酸化剤ガスの露点を燃料ガスの露点よりも低くするように上記ガス加湿手段を制御することを特徴とする請求項６記載の燃料電池システムの制御装置。

【請求項１０】　上記ガス加湿手段は、半透膜を有する加湿媒体流路に加湿媒体が流入され、上記半透膜を介して酸化剤ガス及び燃料ガスと加湿媒体とを接触させて酸化剤ガス及び燃料ガスを加湿する加湿機構を備え、
上記加湿制御手段は、上記加湿媒体流路に供給する冷却媒体の流量を制御して上記酸化剤ガス及び／又は燃料ガスの露点を制御することを特徴とする請求項６～９の何れかに記載の燃料電池システムの制御装置。

【請求項１１】　上記ガス供給手段から上記燃料電池に酸化剤ガスを供給する酸化剤ガス供給流路、及び／又は上記ガス供給手段から上記燃料電池に燃料ガスを供給する燃料ガス供給流路に設けられ、酸化剤ガス及び／又は燃料ガスを上記ガス加湿手段を迂回して上記燃料電池に供給する迂回流路と、
上記迂回流路を通過するガス流量を調整する流量調整手段と、
上記ガス加湿手段を通過するガス流量と上記迂回流路を

通過するガス流量の割合を調整して上記酸化剤ガス及び／又は燃料ガスの露点を制御するように流量調整手段を制御する流量制御手段とを更に備えることを特徴とする請求項６～１０の何れかに記載の燃料電池システムの制御装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、例えば自動車等の駆動源として用いられ、燃料ガスとして水素ガス、酸化剤ガスとして空気が供給されて発電をする燃料電池を駆動する燃料電池システムの制御装置に関し、詳しくは、燃料電池を駆動するに際して空気及び／又は水素ガスの露点を制御する燃料電池システムの制御装置に関する。

【０００２】

【従来の技術】従来の燃料電池システムとしては、発電源として、いわゆる燃料電池スタックを用いたものが知られている。燃料電池スタックは、固体高分子電解質膜を酸化剤極と燃料極とにより挟んで構成された燃料電池構造体が、セパレータを介して複数積層されてなる。このような燃料電池スタックを用いた燃料電池システムとしては、例えば特開平１０－２５５８２８号公報で開示されているものが知られている。

【０００３】この特開平１０－２５５８２８号公報で開示されている燃料電池システムでは、酸化剤として空気、燃料として水素が供給されることにより、比較的低温で作動する固体高分子型燃料電池が説明されている。また、この従来の燃料電池システムでは、燃料電池に発電をさせるに際して、固体高分子電解質膜を十分に湿潤している状態に維持する必要があるために、燃料電池に供給する空気及び水素を純水を用いて加湿する動作をしていた。

【０００４】

【発明が解決しようとする課題】しかしながら、前記従来の燃料電池システムでは、固体高分子電解質膜を湿潤させるに際して、燃料電池に供給する酸化剤ガス及び／又は燃料ガス（以下、単に「供給ガス」と呼ぶ。）に対する加湿量が少なすぎると、電解質膜が乾燥し、十分な発電電力を得ることができないという問題が発生する。

【０００５】一方、従来の燃料電池システムでは、供給ガスに対する加湿量が多すぎると、加湿用として使用する純水の消費量が多くなったり、燃料電池内の凝縮水量が増えることがある。このような状態となると、燃料電池内から凝縮水が排出されにくくなって多量の水が滞留する水詰まりが発生してしまい、十分な発電電力を得ることができない可能性があり、更には燃料電池の構成部品の劣化を促進したりする問題が発生する。

【０００６】そこで、本発明は、上述した問題に鑑みて提案されたものであり、電解質膜の湿潤状態を良好に維持して燃料電池の発電能力を最適化すると共に、加湿用純水消費量の抑制、水詰まりを防止することができる燃料電池システムの制御装置を提供するものである。

【０００７】

【課題を解決するための手段】上述の課題を解決するために、請求項１に係る発明では、電解質膜を酸化剤極と燃料極とにより挟んで構成され、上記酸化剤極側に酸化剤ガスが供給されると共に、上記燃料極側に燃料ガスが供給されて発電する燃料電池と、上記燃料電池に酸化剤ガス及び燃料ガスを供給するガス供給手段と、上記ガス供給手段により上記燃料電池に供給される酸化剤ガス及び燃料ガスを加湿するガス加湿手段とを備えた燃料電池システムを制御する燃料電池システムの制御装置において、上記燃料電池の発電状態を検出する発電状態検出手段と、上記発電状態検出手段で検出された発電状態に応じて、上記ガス供給手段により上記燃料電池に供給される酸化剤ガス、燃料ガスの少なくとも一方の露点を制御するように上記ガス加湿手段を制御する加湿制御手段とを備える。

【０００８】請求項２に係る発明では、請求項１に記載の燃料電池システムの制御装置であって、上記加湿制御手段は、上記発電状態検出手段により検出された発電状態が、第１の所定負荷よりも高い高負荷状態である時には、酸化剤ガス及び／又は燃料ガスの露点を、上記第１の所定負荷時よりも高くするように上記ガス加湿手段を制御する。

【０００９】請求項３に係る発明では、請求項１に記載の燃料電池システムの制御装置であって、上記加湿制御手段は、上記発電状態検出手段により検出された発電状態が、上記第１の所定負荷よりも低い値に設定された第２の所定負荷よりも低い低負荷状態である時には、上記燃料電池の発電状態に対して供給する酸化剤ガス及び／又は燃料ガスの比を所定負荷時よりも高くするように上記ガス供給手段を制御すると共に、酸化剤ガス及び／又は燃料ガスの露点を上記第２の所定負荷時よりも高くするように上記ガス加湿手段を制御する。

【００１０】請求項４に係る発明では、請求項１～３の何れかに記載の燃料電池システムの制御装置であって、半透膜を有する加湿媒体流路に加湿媒体が流入され、上記半透膜を介して酸化剤ガス及び燃料ガスと加湿媒体とを接触させて酸化剤ガス及び燃料ガスを加湿する加湿機構を備え、上記加湿制御手段は、上記加湿媒体流路に供給する冷却媒体の流量を制御して上記酸化剤ガス及び／又は燃料ガスの露点を制御する。

【００１１】請求項５に係る発明では、請求項１～４の何れかに記載の燃料電池システムの制御装置であって、上記ガス供給手段から上記燃料電池に酸化剤ガスを供給する酸化剤ガス供給流路、及び／又は上記ガス供給手段から上記燃料電池に燃料ガスを供給する燃料ガス供給流路に設けられ、酸化剤ガス及び／又は燃料ガスを上記ガス加湿手段を迂回して上記燃料電池に供給する迂回流路と、上記迂回流路を通過するガス流量を調整する流量調

整手段と、上記ガス加湿手段を通過するガス流量と上記迂回流路を通過するガス流量の割合を調整して上記酸化剤ガス及び／又は燃料ガスの露点を制御するように流量調整手段を制御する流量制御手段とを更に備える。

【００１２】上述の課題を解決するために、請求項６に係る発明では、電解質膜を酸化剤極と燃料極とにより挟んで構成され、上記酸化剤極側に酸化剤ガスが供給されると共に、上記燃料極側に燃料ガスが供給されて発電する燃料電池と、上記燃料電池に酸化剤ガス及び燃料ガスを供給するガス供給手段と、上記ガス供給手段により上記燃料電池に供給される酸化剤ガス及び燃料ガスを加湿するガス加湿手段とを備えた燃料電池システムを制御する燃料電池システムの制御装置において、上記燃料電池の温度を検出する温度検出手段と、上記温度検出手段で検出された上記燃料電池の温度に応じて、上記ガス供給手段により上記燃料電池に供給される酸化剤ガス、燃料ガスの少なくとも一方の露点を制御するように上記ガス加湿手段を制御する露点制御手段とを備える。

【００１３】請求項７に係る発明では、請求項６に記載の燃料電池システムの制御装置であって、上記露点制御手段は、上記温度検出手段で検出された上記燃料電池の温度が低いほど、上記酸化剤ガス及び／又は燃料ガスの露点を低くする。

【００１４】請求項８に係る発明では、請求項６に記載の燃料電池システムの制御装置であって、上記露点制御手段は、上記温度検出手段で検出された燃料電池の温度が所定温度よりも高いときには、酸化剤ガスの露点を燃料ガスの露点よりも高くするように上記ガス加湿手段を制御する。

【００１５】請求項９に係る発明では、請求項６に記載の燃料電池システムの制御装置であって、上記露点制御手段は、上記温度検出手段で検出された燃料電池の温度が所定温度よりも低いときには、酸化剤ガスの露点を燃料ガスの露点よりも低くするように上記ガス加湿手段を制御する。

【００１６】請求項１０に係る発明では、請求項６～９の何れかに記載の燃料電池システムの制御装置であって、上記ガス加湿手段は、半透膜を有する加湿媒体流路に加湿媒体が流入され、上記半透膜を介して酸化剤ガス及び燃料ガスと加湿媒体とを接触させて酸化剤ガス及び燃料ガスを加湿する加湿機構を備え、上記加湿制御手段は、上記加湿媒体流路に供給する冷却媒体の流量を制御して上記酸化剤ガス及び／又は燃料ガスの露点を制御する。

【００１７】請求項１１に係る発明では、請求項６～１０の何れかに記載の燃料電池システムの制御装置であって、上記ガス供給手段から上記燃料電池に酸化剤ガスを供給する酸化剤ガス供給流路、及び／又は上記ガス供給手段から上記燃料電池に燃料ガスを供給する燃料ガス供給流路に設けられ、酸化剤ガス及び／又は燃料ガスを上記ガス加湿手段を迂回して上記燃料電池に供給する迂回流路と、上記迂回流路を通過するガス流量を調整する流量調整手段と、上記ガス加湿手段を通過するガス流量と上記迂回流路を通過するガス流量の割合を調整して上記酸化剤ガス及び／又は燃料ガスの露点を制御するように流量調整手段を制御する流量制御手段とを更に備える。

【００１８】

【発明の効果】請求項１に係る発明によれば、燃料電池に供給される酸化剤ガス、燃料ガスの少なくとも一方の露点を制御するようにガス加湿手段を制御するので、最適な露点に制御して酸化剤ガス又は燃料ガスを燃料電池に供給することができ、電解質膜の湿潤状態を良好に維持して燃料電池の発電能力を最適化すると共に、加湿用純水消費量の抑制、水詰まりの防止をすることができる。すなわち、請求項１に係る発明によれば、燃料電池の運転状態に拘わらず、電解質膜の湿潤状態を良好に維持することにより、電解質膜の乾燥や水詰まりによる発電効率低下を抑制して燃料電池の発電能力を最適化することができ、更に、高負荷状態時及び低負荷状態時で同じ露点とした場合と比較して加湿用純水消費量の抑制を実現することができる。

【００１９】請求項２に係る発明によれば、第１の所定負荷よりも高い高負荷状態である時には、酸化剤ガス及び／又は燃料ガスの露点を、第１の所定負荷時よりも高くするので、燃料電池の高負荷状態時に発生しやすい電解質膜の乾燥を防止することができる。

【００２０】請求項３に係る発明によれば、発電状態が上記第１の所定負荷よりも低い値に設定された第２の所定負荷よりも低い低負荷状態である時には、燃料電池の発電状態に対して供給する酸化剤ガス及び／又は燃料ガスの比を上記第２の所定負荷時よりも高くすると共に、酸化剤ガス及び／又は燃料ガスの露点を所定負荷時よりも高くするので、酸化剤ガス及び／又は燃料ガスの燃料電池内の流速を大きくして水詰まりを抑制できると共に、酸化剤ガス及び／又は燃料ガスの流速を大きくしたことによる電解質膜の乾燥を防止することができ、請求項１及び請求項２に係る発明と比較して、より確実に電解質膜の乾燥防止と水詰まり防止とをより確実に両立させることができる。

【００２１】請求項４に係る発明によれば、加湿媒体流路に供給する冷却媒体の流量を制御して酸化剤ガス及び／又は燃料ガスの露点を制御するので、最適な露点に制御して酸化剤ガス又は燃料ガスを燃料電池に供給することができ、電解質膜の湿潤状態を良好に維持して燃料電池の発電能力を最適化すると共に、加湿用純水消費量の抑制、水詰まりを防止することを実現することができる。

【００２２】請求項５に係る発明によれば、ガス加湿手段を通過するガス流量と迂回流路を通過するガス流量の割合を調整して酸化剤ガス及び／又は燃料ガスの露点を

制御するので、迂回流路を備えることにより、酸化剤ガスと燃料ガスとで独立して露点を制御することができる。したがって、この請求項５に係る発明によれば、請求項１～請求項３に係る発明と比較して、更に、電解質膜の乾燥や水詰まりによる発電効率低下を抑制して燃料電池の発電能力を最適化することができる。更に、この請求項５に係る発明によれば、加湿用純水消費量の抑制を実現することができる。

【００２３】請求項６に係る発明によれば、燃料電池の温度に応じて、ガス供給手段により燃料電池に供給される酸化剤ガス、燃料ガスの少なくとも一方の露点を制御するので、最適な露点に制御して酸化剤ガス又は燃料ガスを燃料電池に供給することができ、電解質膜の湿潤状態を良好に維持して燃料電池の発電能力を最適化すると共に、加湿用純水消費量の抑制、水詰まりを防止することができる。すなわち、請求項６に係る発明によれば、燃料電池の運転状態に拘わらず、電解質膜の湿潤状態を良好に維持することにより、電解質膜の乾燥や水詰まりによる発電効率低下を抑制して燃料電池の発電能力を最適化することができ、更に、高負荷状態時及び低負荷状態時で同じ露点とした場合と比較して加湿用純水消費量の抑制を実現することができる。

【００２４】請求項７に係る発明によれば、燃料電池の温度が低いほど、酸化剤ガス及び／又は燃料ガスの露点を低くするので、燃料電池の温度が低い場合には、露点の変化に対する飽和蒸気圧の変化が少ないため、燃料電池の燃料極及び酸化剤極での燃料ガス量及び酸化剤ガス量に対する水分量の割合が増加し、より多くの水分が凝縮することに対応することができる。

【００２５】請求項８に係る発明によれば、燃料電池の温度が所定温度よりも高いときには、酸化剤ガスの露点を燃料ガスの露点よりも高くするので、酸化剤極における電解質膜の乾燥防止と水詰まりの発生防止を実現することができる。

【００２６】請求項９に係る発明によれば、燃料電池の温度が所定温度よりも低いときには、酸化剤ガスの露点を燃料ガスの露点よりも低くするので、酸化剤極における水詰まり発生防止を実現することができる。

【００２７】請求項１０に係る発明によれば、加湿媒体流路に供給する冷却媒体の流量を制御して酸化剤ガス及び／又は燃料ガスの露点を制御するので、最適な露点に制御して酸化剤ガス又は燃料ガスを燃料電池に供給することができ、電解質膜の湿潤状態を良好に維持して燃料電池の発電能力を最適化すると共に、加湿用純水消費量の抑制、水詰まりを防止することを実現することができる。

【００２８】請求項１１に係る発明によれば、ガス加湿手段を通過するガス流量と迂回流路を通過するガス流量の割合を調整して酸化剤ガス及び／又は燃料ガスの露点を制御するので、迂回流路を備えることにより、酸化剤ガスと燃料ガスとで独立して露点を制御することができる。したがって、この請求項５に係る発明によれば、請求項１～請求項３に係る発明と比較して、更に、電解質膜の乾燥や水詰まりによる発電効率低下を抑制して燃料電池の発電能力を最適化することができる。更に、この請求項５に係る発明によれば、加湿用純水消費量の抑制を実現することができる。

【００２９】

【発明の実施の形態】以下、本発明の実施の形態について図面を参照して説明する。

【００３０】本発明は、例えば図１に示すように構成された燃料電池システムに適用される。

【００３１】［燃料電池システムの構成］この燃料電池システムは、水素含有ガス及び燃料ガスが供給されて発電する燃料電池スタック１を備えるものである。この燃料電池スタック１は、例えば固体高分子電解質膜を挟んで燃料極（水素極１ａ）と酸化剤極（空気極１ｂ）を対設した燃料電池構造体をセパレータで狭持した複数の燃料電池構造体からなる。この燃料電池スタック１は、空気極１ｂ側に酸化剤ガスとして空気が供給されるとともに、水素極１ａ側に燃料ガスとして水素ガスが供給されることで発電をして、例えば自動車等の駆動源として利用される。

【００３２】燃料電池システムは、水素タンク２に蓄えられた水素ガスを、水素調圧弁３により調圧した後、エゼクタポンプ４、加湿器５を介して燃料電池スタック１に供給する水素ガス供給流路Ｌ１を備える。

【００３３】水素調圧弁３は、コントロールユニット１８からの制御信号に従って開閉動作することで、燃料電池システム内での水素ガスの圧力を調整する。加湿器５は、例えばパイプ状に成形された半透膜内に純水を通過させる構成となっており、エゼクタポンプ４からの水素ガス及びコンプレッサ６からの空気を半透膜と接触させることで、半透膜を介した水素ガス及び空気の加湿をする構成となっている。

【００３４】また、この燃料電池システムは、水素極１ａ側からの水素ガスと水蒸気の混合ガスとなった排気ガスを、エゼクタポンプ４に供給して再度加湿器５を介して燃料電池スタック１に供給する水素ガス循環流路Ｌ２を備える。

【００３５】更に、この燃料電池システムは、外部からの空気を、コンプレッサ６、加湿器５を介して燃料電池スタック１に供給する空気供給流路Ｌ３を備える。コンプレッサ６は、コントロールユニット１８からの制御信号に従った流量の空気を空気供給流路Ｌ３を介して燃料電池スタック１に供給する。

【００３６】この燃料電池システムにおいて、燃料電池スタック１からの空気極１ｂ側の排気ガスは水蒸気と液水とを含み、水分離器７によって液水分と水蒸気とに分離され、液水分が純水タンク８に蓄えられ、水蒸気が空

気調圧弁９を介して外部に排出されるように構成されている。空気調圧弁９は、コントロールユニット１８からの制御信号に従って開閉動作することで燃料電池システム内での空気の圧力を調整する。

【００３７】更にまた、この燃料電池システムは、燃料電池スタック１内に冷却水を循環させる冷却水循環流路Ｌ４と、燃料電池スタック１に供給する水素ガス及び燃料ガスを加湿するための純水を循環させる純水循環流路Ｌ５とを更に備える。この冷却水循環流路Ｌ４及び純水循環流路Ｌ５には、冷却水と純水との間で熱交換をする中間熱交換器１１が配設されている。

【００３８】この冷却水循環流路Ｌ４には、冷却水ポンプ１０、熱交換器１１、ラジエタ１２が配設されている。この燃料電池システムでは、冷却水ポンプ１０を駆動することにより、冷却水を燃料電池スタック１内に流入させ、燃料電池スタック１からの冷却水を中間熱交換器１１により純水循環流路Ｌ５の純水との間で熱交換をさせ、燃料電池スタック１の発熱により高温度となった冷却水をラジエタ１２により冷却して冷却水ポンプ１０に循環させる。これにより、燃料電池システムは、冷却水により燃料電池スタック１を所定の温度に維持する。

【００３９】純水循環流路Ｌ５には、純水タンク８に蓄積された純水を加湿器５に導く加湿用純水ポンプ１３と、中間熱交換器１１とが配設されている。この燃料電池システムでは、加湿用純水ポンプ１３を駆動することにより、純水タンク８に蓄積された純水を中間熱交換器１１に供給して純水を冷却水との間で熱交換させて加熱させて加湿器５に供給する。これにより、加湿器５内では、例えばパイプ状の半透明膜内に純水が供給され、半透明膜に水素ガス及び空気が通過することにより水素ガス及び空気に加湿をする。

【００４０】更に、燃料電池システムでは、コンプレッサ６の前段に設けられ空気の流量を検出する空気流量センサ１４と、燃料電池スタック１に供給される水素ガスの圧力を検出する水素圧力センサ１５と、燃料電池スタック１に供給される空気の圧力を検出する空気圧力センサ１６と、燃料電池スタック１と接続されて燃料電池スタック１の発電状態又は温度を検出する状態センサ１７とを備える。各センサ１４～１７は、検出して得たセンサ信号をコントロールユニット１８に供給する。

【００４１】コントロールユニット１８は、各センサ１４～１７からのセンサ信号に基づいて、燃料電池システムの各部を制御する制御信号を出力する。コントロールユニット１８は、燃料電池スタック１の状態に応じて、燃料電池スタック１に供給する水素ガス及び／又は空気の露点を制御する露点制御処理をする。

【００４２】［燃料電池システムの動作］以下、上述の燃料電池システムの動作として、コントロールユニット１８による第１露点制御処理～第４露点制御処理について説明する。

【００４３】「第１露点制御処理」第１露点制御処理では、コントロールユニット１８は、燃料電池スタック１からの取り出し電流（負荷）が大きい場合に、水素ガス及び／又は空気の露点を高くする。このとき、コントロールユニット１８は、状態センサ１７からセンサ信号に基づいて燃料電池スタック１の発電状態、すなわち燃料電池スタック１の負荷を認識し、負荷の大きさに応じて露点を高くするように加湿用純水ポンプ１３の駆動量を多くして、多くの純水流量を加湿器５に供給する制御をする。

【００４４】ここで、燃料電池スタック１の水素極１ａにおいては水素が反応により消費され（$H_2 \rightarrow 2H^+ + 2e^-$）、空気極１ｂにおいては空気に含まれる酸素と、水素極１ａからの水素（$2H^+$）との反応により水が生成される（$1/2O_2 + 2H^+ + 2e^- \rightarrow H_2O$）。空気及び水素ガスの露点が低すぎると特にガス入口付近において高分子電解質膜が乾燥し、発電効率の低下、電解質膜の劣化の促進となる。逆に、空気及び水素ガスの露点が高すぎると燃料電池スタック１内に大量の液水が凝縮するため、水詰まりが発生しやすくなる。これに対し、コントロールユニット１８では、上記第１露点制御処理をする。

【００４５】また、燃料電池スタック１の性質上、図３に示すように燃料電池スタック１からの取り出し電流が大きい、すなわち高負荷であるほど、燃料電池スタック１の発熱量が大きくなるため、燃料電池スタック１からの取り出し電流が大きいほど、燃料電池スタック１の冷却水出口における冷却水温度と燃料電池スタック１の冷却水入口における冷却水温度との温度差が大きくなる。このため、燃料電池スタック１からの取り出し電流が大きいほど燃料電池スタック１の平均温度が高くなる。

【００４６】更に、燃料電池スタック１は、図４に示すように、水素ガス及び／又は空気の露点が高くなるほど、飽和蒸気圧が急激に増加する。

【００４７】図３及び図４より、燃料電池スタック１が高負荷状態であるほど、燃料電池スタック１内での飽和水蒸気圧が増加して液水分が凝縮しにくいことを示す。従って、高分子電解質膜の乾燥を防ぐために、コントロールユニット１８は、図５に示すようなテーブルを参照して、燃料電池スタック１が高負荷状態であるときには加湿器５の出口における空気及び／又は水素ガスの露点を高く制御する。図５に示すテーブルは、加湿器５に流す純水流量と加湿器５から燃料電池スタック１に供給する水素ガス及び／又は空気の露点との関係を示し、コントロールユニット１８により燃料電池スタック１に要求される露点に基づいた加湿用純水ポンプ１３の駆動量制御がされる。

【００４８】ここで、コントロールユニット１８は、燃料電池スタック１が低負荷状態である場合に高負荷状態と同じ露点とする制御をすると、高分子電解質膜の乾燥

を発生させないが、液水分の凝縮割合が増えて水詰まりが発生しやすくなるために、高負荷状態時の露点よりも低くする。

【００４９】この第１露点制御処理をするコントロールユニット１８を備えた燃料電池システムによれば、高負荷状態時には水素ガス及び／又は空気の露点を高くするように加湿用純水ポンプ１３の駆動量を大きくして電解質膜の乾燥を防止し、低負荷状態時には高負荷状態時の露点より低くするように加湿用純水ポンプ１３の駆動量を小さくして水詰まりの発生を防止する。

【００５０】したがって、この燃料電池システムによれば、燃料電池スタック１の運転状態に拘わらず、電解質膜の湿潤状態を良好に維持することにより、高分子電解質膜の乾燥や水詰まりによる発電効率低下を抑制して燃料電池の発電能力を最適化することができる。更に、この燃料電池システムによれば、高負荷状態時及び低負荷状態時で同じ加湿用純水ポンプ１３の駆動量とした場合と比較して加湿用純水消費量の抑制を実現することができる。

【００５１】なお、上述の第１の所定負荷と第２の所定負荷との間の領域は燃料電池の運転範囲中、中負荷領域を意図するものである。

【００５２】「第２露点制御処理」第２露点制御処理では、供給ガスの流速が遅いことにより発生しやすい、すなわち燃料電池スタック１へのガス供給量の少ない低負荷状態時には水詰まりが発生しやすいことに対応した制御をする。

【００５３】第２露点制御処理において、コントロールユニット１８は、燃料電池スタック１の低負荷状態時には、低負荷状態時外よりも、ストイキ比（ＳＲ）を高くするように水素調圧弁３及び／又はコンプレッサ６を制御する。ここで、ストイキ比とは、燃料電池スタック１内での反応ガス量に対する供給ガス量の比であり、通常状態では「１」より大きな値に制御される。

【００５４】また、この第２露点制御処理において、コントロールユニット１８は、図６に示すように低負荷状態時のストイキ比を高くすると共に、図７に示すように低負荷状態時の露点を高くする制御をする。コントロールユニット１８は、内部に図６及び図７に示すようなテーブルを記憶し、状態センサ１７からのセンサ信号に基づいてテーブルを参照してストイキ比及び露点を認識して水素調圧弁３、コンプレッサ６又は加湿用純水ポンプ１３を制御する。

【００５５】これにより、第２露点制御処理では、ストイキ比を高くすると、水素極１ａでは供給した水素量に対する消費される水素量の割合が減ると共に、空気極１ｂでは供給した空気量に対する反応生成水量の割合が減り、燃料電池スタック１内で供給ガスに対する水分の割合が低下して高分子電解質膜が乾燥しやすくなるのに対応する。

【００５６】したがって、第２露点制御処理を行うコントロールユニット１８を備えた燃料電池システムによれば、燃料電池スタック１が低負荷状態であるときに、酸化剤ガス及び／又は燃料ガスの燃料電池内の流速を大きくして水詰まりを抑制できると共に、酸化剤ガス及び／又は燃料ガスの流速を大きくしたことによる電解質膜の乾燥を防止することができ、第１露点制御処理と比較して、より確実に高分子電解質膜の乾燥防止と水詰まり防止とをより確実に両立させることができる。

【００５７】「第３露点制御処理」第３露点制御処理では、燃料電池スタック１の温度に基づいて、水素ガス及び／又は空気の露点を制御する。ここで、燃料電池スタック１の温度としては、例えば燃料電池スタック１の冷却水入口付近の冷却水温度を用いる。コントロールユニット１８は、燃料電池スタック１の温度を示すセンサ信号を状態センサ１７から入力して、予め記憶した図８に示すようなテーブルを参照し、燃料電池スタック１の温度が低いほど、空気及び／又は水素ガスの露点を低くし、燃料電池スタック１の温度と水素ガス及び／又は空気の露点との差を負方向に大きくする。

【００５８】これにより、燃料電池スタック１の温度が低い場合には、図４に示すように露点の変化に対する飽和蒸気圧の変化が少ないため、燃料電池スタック１の水素極１ａ及び空気極１ｂでの水素ガス量及び空気量に対する水分量の割合が増加し、より多くの水分が凝縮することに対応することができる。

【００５９】「第４露点制御処理」第４露点制御処理では、図９に示すように、水素ガス供給流路Ｌ１に水素極１ａをバイパスする水素バイパス流路Ｌ１１、空気供給流路Ｌ３に空気極１ｂをバイパスする空気バイパス流路Ｌ１２を設け、水素バイパス流路Ｌ１１に水素バイパス弁２１、空気バイパス流路Ｌ１２に空気バイパス弁２２を設けた燃料電池システムにおいて、コントロールユニット１８により水素ガス及び／又は空気の露点を別個に制御する。このとき、コントロールユニット１８は、可変絞り弁である水素バイパス弁２１及び空気バイパス弁２２の開度を別個に制御することにより、水素ガスと空気とで別個に露点を制御する。このとき、コントロールユニット１８は、加湿器５を通過する水素ガス量と加湿器５を通過しない水素ガス量との割合、及び加湿器５を通過する空気量と加湿器５を通過しない空気量との割合、を制御する。

【００６０】第４露点制御処理を行うとき、コントロールユニット１８は、予め記憶した図１０に示すようなテーブルを参照し、燃料電池スタック１の温度が所定温度Ｔよりも低いときには空気の露点を水素ガスの露点よりも低くし、燃料電池スタック１の温度が所定温度Ｔよりも高い時には空気の露点を水素ガスの露点よりも高くするように、水素バイパス弁２１及び空気バイパス弁２２の開度を制御する。

【００６１】これにより、水素極１ａについては内部の反応で水分量が増加することはなく加湿器５による加湿で導入された水分の凝縮のみを考慮し、空気極については加湿器５による加湿で導入された水分及び反応により発生する水分を考慮した露点の制御を行う。

【００６２】燃料電池スタック１の温度が低い場合には、飽和水蒸気圧が低いため、加湿器５から水素極１ａ及び空気極１ｂに導入される水分量が小さく、水素極１ａでは凝縮水、空気極１ｂでは反応生成水及び凝縮水が滞留する。したがって、コントロールユニット１８では、空気の露点を水素ガスの露点よりも低くするように水素バイパス弁２１及び空気バイパス弁２２を制御する第４露点制御処理をする。

【００６３】燃料電池スタック１の温度が高い場合には、高分子電解質膜を乾燥させないために水素ガス及び空気の燃料電池スタック１に必要な水分が多くなって、加湿器５から燃料電池スタック１に供給する水分量が多くなる。この場合、水素極１ａでは反応による水素消費により内部ガス量に対する水分量の割合が高くなり、空気極１ｂでは反応生成水が滞留するが空気中に反応しない窒素を大量に含むため、内部ガス量に対する水分量の割合が水素極１ａよりも少なくなる。したがって、コントロールユニット１８は、空気の露点を水素ガスの露点よりも高くするように水素バイパス弁２１及び空気バイパス弁２２を制御する第４露点制御処理をする。

【００６４】このような第４露点制御処理を行うコントロールユニット１８を備えた燃料電池システムによれば、水素バイパス弁２１及び空気バイパス弁２２を備えることにより、水素ガスと空気とで独立して露点を制御することができる。したがって、この燃料電池システムによれば、水素極１ａと空気極１ｂとで滞留する液滴量の差に基づいた露点の制御をすることができ、水素極１ａ及び空気極１ｂごとに電解質膜の乾燥や水詰まりによる発電効率低下を抑制して燃料電池の発電能力を最適化することができる。更に、この燃料電池システムによれば、高負荷状態時及び低負荷状態時で同じ加湿用純水ポンプ１３の駆動量とした場合と比較して加湿用純水消費量の抑制を実現することができる。

【００６５】なお、この第４露点制御処理では、燃料電池スタック１の温度に応じて水素ガス及び／又は空気の露点を独立して制御する一例について説明したが、燃料電池スタック１の負荷に基づいて水素ガス及び／又は空気の露点を独立して制御しても同様の効果を発揮することができる。

【００６６】また、この第４露点制御処理では、水素ガス供給流路Ｌ１に水素バイパス流路Ｌ１１を設けると共に、空気供給流路Ｌ３に空気バイパス流路Ｌ１２を設ける一例について説明したが、水素ガス供給流路Ｌ１、空気供給流路Ｌ３の何れかにバイパス流路を設けた場合であっても、上述と同様の効果を得ることができる。

【００６７】なお、上述の実施の形態は本発明の一例である。このため、本発明は、上述の実施形態に限定されることはなく、この実施の形態以外であっても、本発明に係る技術的思想を逸脱しない範囲であれば、設計等に応じて種々の変更が可能であることは勿論である。

【００６８】また、上述の燃料電池システムでは、加湿器５内の半透膜に純水を流して水素ガス及び／又は空気を加湿する場合について説明したが、これに限らず、例えば純水を水素ガス供給流路Ｌ１内や空気供給流路Ｌ３内で噴射するようにしても良い。このとき、コントロールユニット１８では、水素ガス及び／又は空気の露点を制御するに際して、水素ガス供給流路Ｌ１内及び／又は空気供給流路Ｌ３内での噴射量を制御することで、上述と同様の露点制御処理をすることができる。

【図面の簡単な説明】

【図１】本発明を適用した燃料電池システムの構成を示すブロック図である。

【図２】燃料電池スタックから取り出す電流の大きさと、露点との関係を説明するための図である。

【図３】燃料電池スタックから取り出す電流の大きさと、燃料電池スタックの冷却水出口での冷却水温度と冷却水入口での冷却水温度との温度差と、の関係を説明するための図である。

【図４】水素ガス及び空気の露点と、飽和水蒸気圧との関係を説明するための図である。

【図５】加湿器に流す純水流量と加湿器から燃料電池スタックに供給する水素ガス及び／又は空気の露点との関係を示す図である。

【図６】第２露点制御処理における制御内容を説明するための図であって、燃料電池スタックから取り出す電流と、水素ガス及び／又は空気のストイキ比との関係を示す図である。

【図７】第２露点制御処理における制御内容を説明するための図であって、燃料電池スタックから取り出す電流と、水素ガス及び／又は空気の露点との関係を示す図である。

【図８】第３露点制御処理における制御内容を説明するための図であって、燃料電池スタックの温度と、燃料電池スタックの温度と水素ガス及び／又は空気の露点との差との関係を示す図である。

【図９】第４露点制御処理における燃料電池システムにおける要部構成図である。

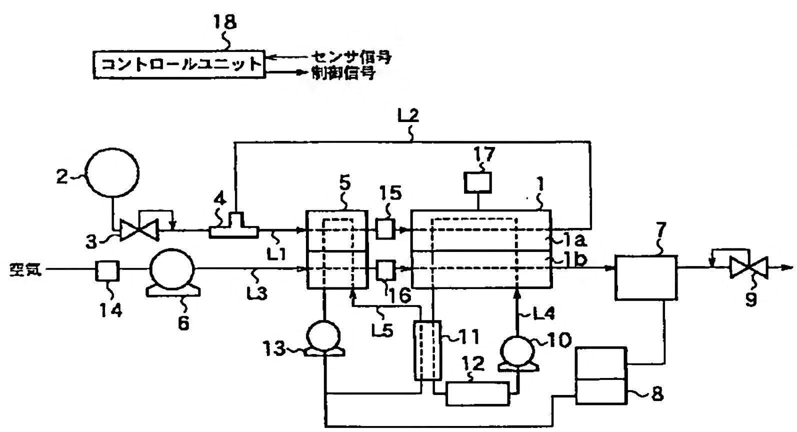
【図１０】第４露点制御処理における制御内容を説明するための図であって、燃料電池スタックの温度と、水素ガス及び／又は空気の露点との関係を示す図である。

【符号の説明】

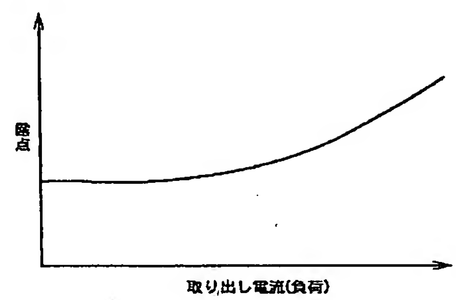
１　燃料電池スタック
２　水素タンク
３　水素調圧弁
４　エゼクタポンプ

５　加湿器
６　コンプレッサ
７　水分離器
８　純水タンク
９　空気調圧弁
１０　冷却水ポンプ
１１　中間熱交換器
１２　ラジエタ
１３　加湿用純水ポンプ
１４　空気流量センサ
１５　水素圧力センサ
１６　空気圧力センサ
１７　状態センサ
１８　コントロールユニット
２１　水素バイパス弁
２２　空気バイパス弁

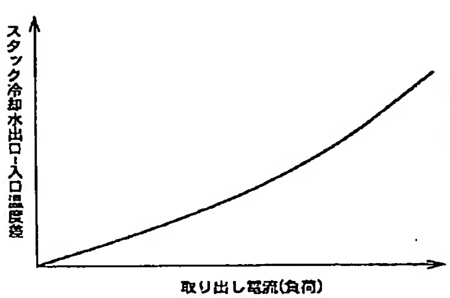
【図１】



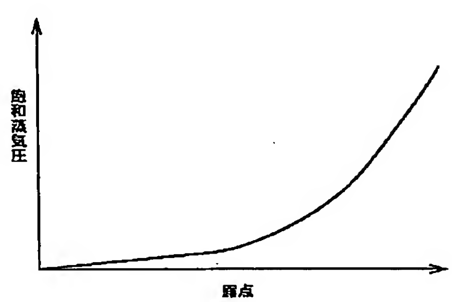

【図２】



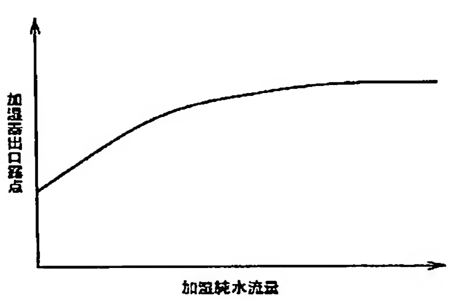

【図３】



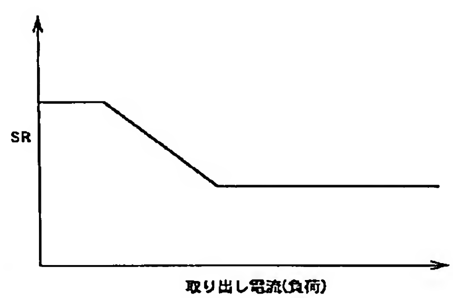

【図４】



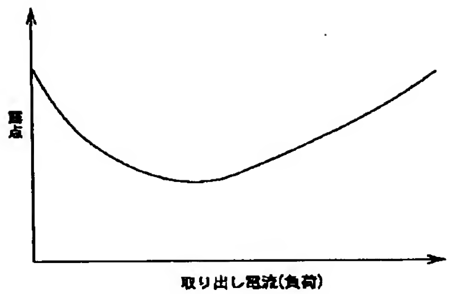

【図５】



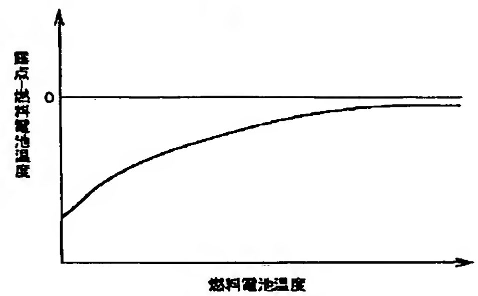

【図６】



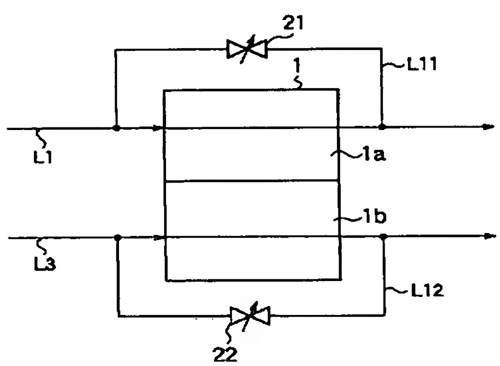
【図７】


露点
取り出し電流(負荷)

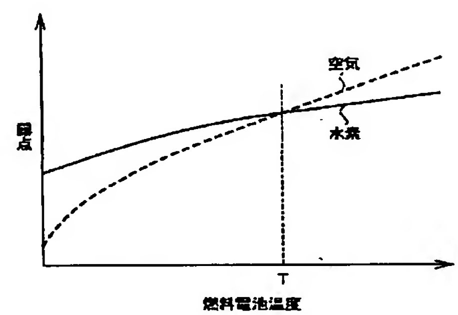
【図８】


露点−燃料電池温度
0
燃料電池温度

【図９】


21
1
L11
L1
1a
1b
L3
L12
22

【図１０】


空気
水素
露点
T
燃料電池温度